Mariners Weather Log

Spring 1991

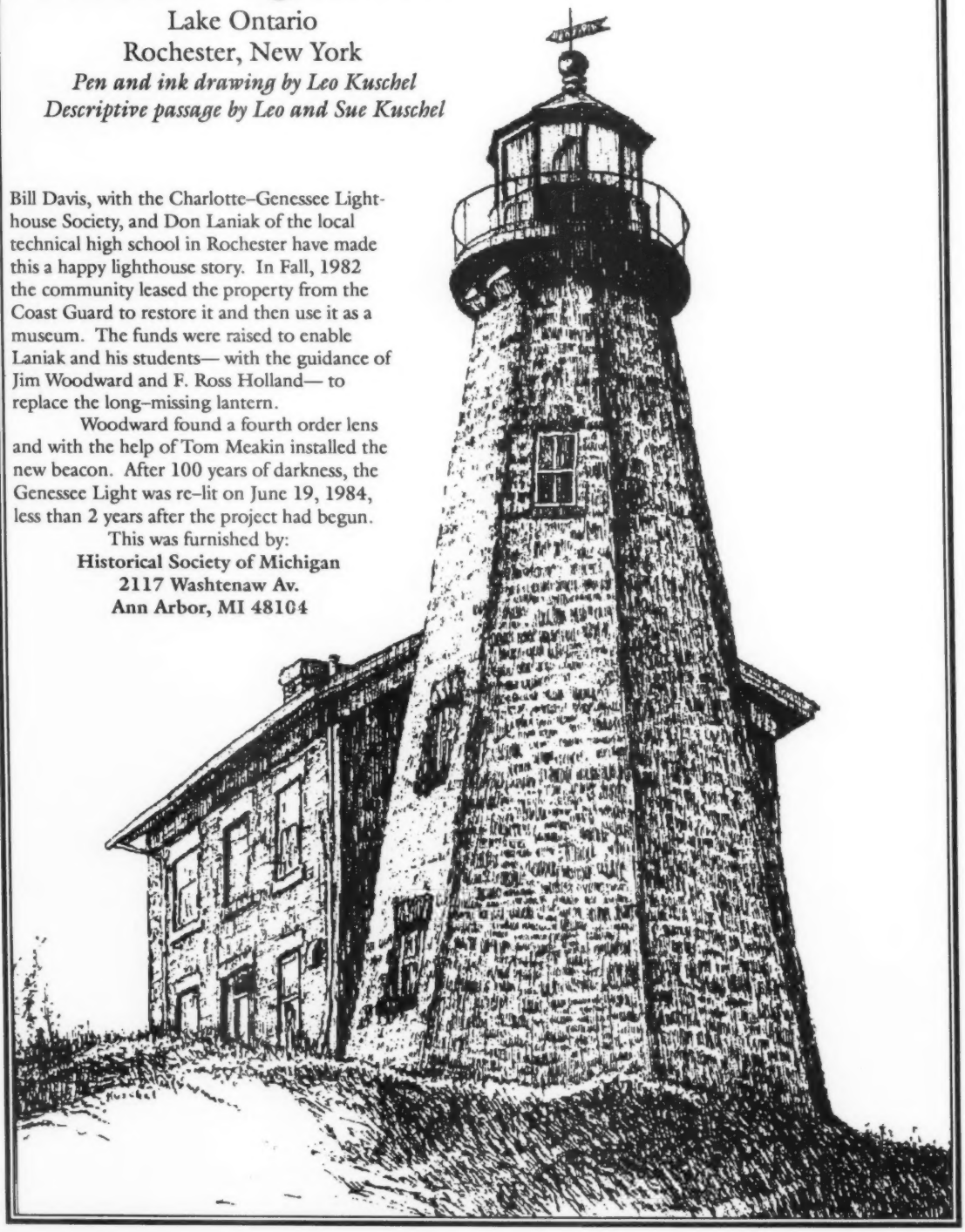
Genessee Lighthouse

Lake Ontario
Rochester, New York
Pen and ink drawing by Leo Kuschel
Descriptive passage by Leo and Sue Kuschel

Bill Davis, with the Charlotte–Genessee Lighthouse Society, and Don Laniak of the local technical high school in Rochester have made this a happy lighthouse story. In Fall, 1982 the community leased the property from the Coast Guard to restore it and then use it as a museum. The funds were raised to enable Laniak and his students— with the guidance of Jim Woodward and F. Ross Holland— to replace the long–missing lantern.

Woodward found a fourth order lens and with the help of Tom Meakin installed the new beacon. After 100 years of darkness, the Genessee Light was re–lit on June 19, 1984, less than 2 years after the project had begun.

This was furnished by:
Historical Society of Michigan
2117 Washtenaw Av.
Ann Arbor, MI 48104



Mariners Weather Log

April, May and June 1991
Vol. 35, No. 2

The Split Rock Lighthouse was built in the Summer of 1910. Elinor DeWire tells us how— Page 36.

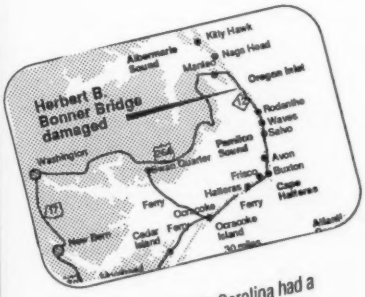
Features

4
The Bonner Bridge Storm
Victor F. Morris
The story of the October 1990 storm that caused the problems for residents and visitors on North Carolina's Outer Banks.

10
Soviet – American Sail, 1990
LCDR Craig McLean
An historic joint training cruise aboard a Soviet Tall ship.

16
North Atlantic Hurricanes, 1990
Max Mayfield
A year that was active but spared the U.S.

24
Eastern North Pacific Hurricanes—1990
Lixion Avila
A year that featured two of the strongest hurricanes ever in this basin.



The Outer Banks of North Carolina had a rough fall; story on page 4.

To the right is the National Hurricane Center seal. Their review begins on page 16.

Departments

31 Ocean Queries
36 Whale Oil and Wicks
40 Sea Photography
42 Editor's Desk
46 PMO Report
49 Mailbag
51 Marine Observation Program
54 Radio Officer Tips
57 Hurricane Alley

Marine Weather Review

October, November and December 1990

62 North Atlantic Ocean
72 North Pacific Ocean
83 Track Charts
90 Tables

Cover: *The Soviet Tall Ship* ***Druzhba*** *provided a unique training opportunity for American cadets. Photo by LCDR Craig McLean.*

Back Cover: *Seattle was rocked this fall and winter by some unusually rough weather. This was the view on December 29, 1990 from Alki Beach. Photo by Tom Reese, Seattle Times.*

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New Zealand Pacific

A Salute to the Heroes

The last issue of the Mariners Weather Log featured— *We fought Cape Horn...and the Horn Won*, by Richard Wilson. We would like to pay further tribute to the heroes of that story— the crew of the ***New Zealand Pacific***. These men risked their lives to save the two stranded sailors in conditions that only real Cape–Horners can appreciate. While this rescue is part of what is expected of a mariner, it is just such selfless actions, through the centuries, that have put their code of honor in a class by itself. We no longer have Knights and Good Samaritans are hard to come by these days, so when you search for true heroes look to the sea. We are also proud to say that the vessel is an excellent weather reporter in the New Zealand Voluntary Reporting Ship program. For an account of the rescue by David Watt, Master of the ***New Zealand Pacific***, see the Editors Desk on page 42.

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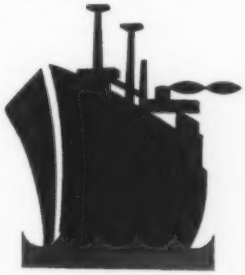

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The Herbert C. Bonner Bridge has been serving the Outer Banks of North Carolina for more than a quarter of a century. While it has withstood hurricanes and severe winter storms during that period, the ramming by the barge **Northerly Island** *was too much. The fast–developing storm produced only minor overwash from the ocean, but soundside flooding on Hatteras was reported to be the "worst in many years." Two to three feet of water covered many yards in Frisco and parts of Highway 12. A woman drowned when she drove her car into a flooded area and lost control in the predawn hours of the 26th, near the Cedar Island Bridge on Highway 12.*

On October 26, 1990 a section of bridge was added to the graveyard of ships along the Outer Banks and the associated weather system became known as

The Bonner Bridge Storm

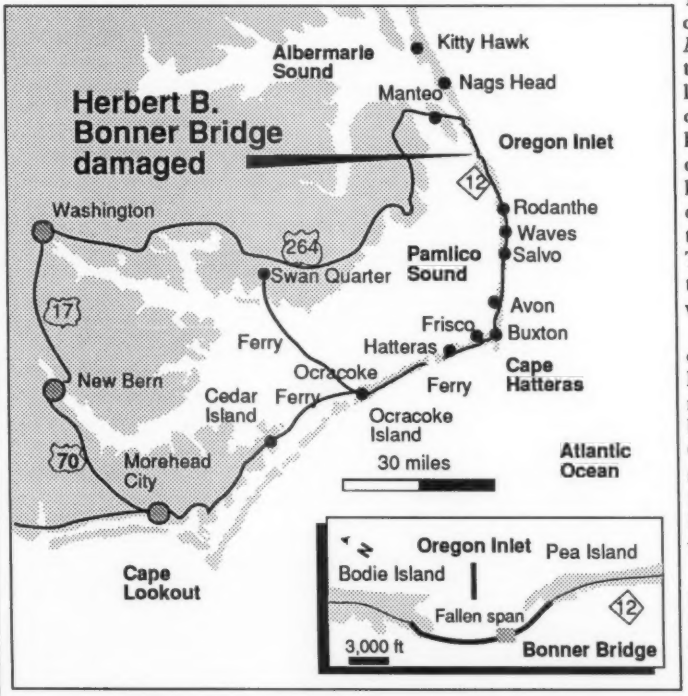
Professor Victor F. Morris
Embry–Riddle Aeronautical University

Michael Halminski

North Carolina's Outer Banks frequently experience the violent forces of nature. Major Atlantic hurricanes and wild winter storms have sunk over 1,500 vessels in this *graveyard of ships.* Contrasting waters of the Gulf Stream and the icy Labrador Current often provide the fuel for explosive storm development during the fall and winter.

In addition to being a professor of Aeronautical Science at Embry Riddle, Victor Morris has written **The Weather Surfer** and turns out the Sea Watch column in **The Surf Report**. His *Florida Beach Erosion* appeared in **Weatherwise** and he is the East Coast Chief Meteorologist for Surf Line Inc.

The Herbert C. Bonner Bridge

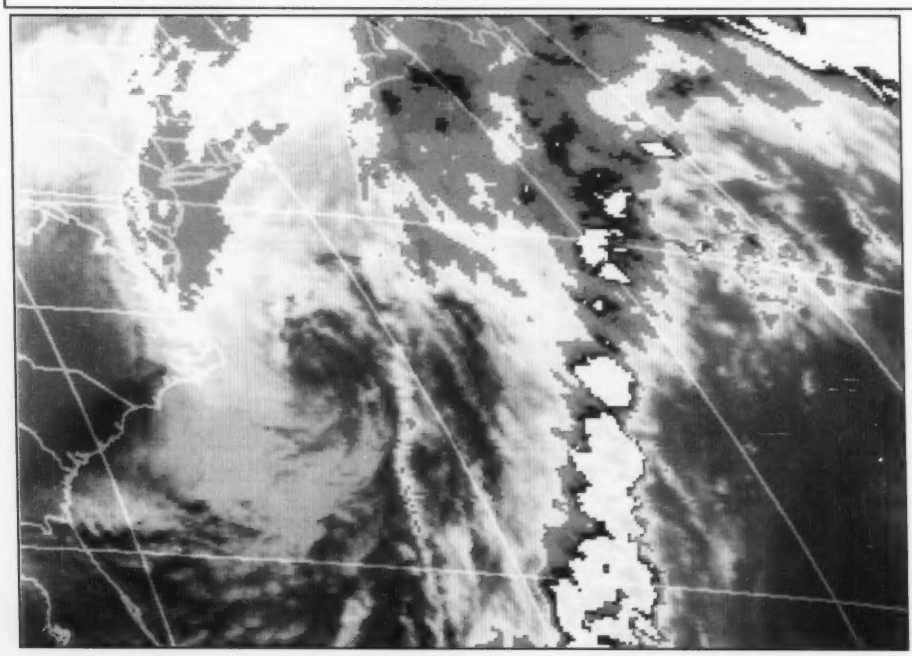


Original Artwork by Robert Holst, of the **Morning Star**, Wilmington, NC

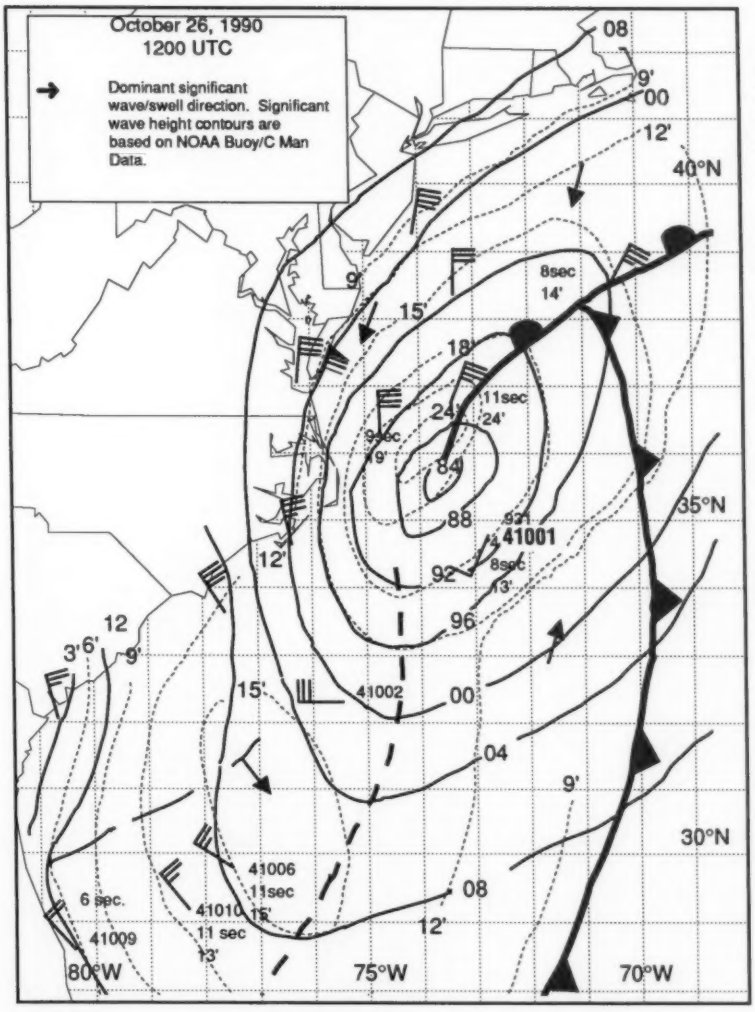
The bridge was struck at 1:28 a.m. EDT on October 26, 1990 by the dredge ***Northerly Island***. A 369–foot segment of the bridge collapsed into Oregon Inlet less than 1 hour later. At the time winds of 40 to 45 knots were gusting to 50 knots. The dredge, which was under contract to repair the channel, broke loose from its moorings. Four of the ten crewmen on the dredge scrambled to the top of the bridge before it collapsed. The other six stayed aboard to help save the vessel. The Coast Guard reported all were safe.

The collapse of the 26–year old bridge left thousands stranded on Hatteras Island. In addition to the 5,000 residents, there were an unknown number of tourists. The ferry service to Ocracoke Island, south of Hatteras, was suspended during the storm. Power and telephone lines carried to Hatteras Island by the bridge, were damaged when the section collapsed.

The accident occurred at the peak of the surf fishing season and was expected to cost the local economy about $18 to $20 million. The bridge was reopened on February 11, 1991, just 110 days after the collapse. The repairs cost $5.8 million.



The satellite photograph was taken at 1700 UTC on the 26th. It is a GOES infrared enhanced image. The weather charts for the 26th (on pages 7 – 9) were analyzed by the author. The ship reports that were received by this office coincided nicely with the analysis and the buoy reports.



On October 26, 1990 some 370 feet of the Bonner Bridge spanning Oregon Inlet became the latest addition to this Atlantic graveyard.

Although designed to withstand hurricane winds, the bridge failed after it was struck by an out–of–control dredging barge, ***Northerly Island***. This accident severed the sole highway link between Hatteras Island and the mainland of North Carolina.

Favorable Conditions

Weather charts on October 24, 1990 indicated a broad upper air trough was located in the central United States near 90°W. The following day the trough intensified and moved to Kentucky. Conditions became favorable for surface cyclogenesis, and a surface low formed near Wilmington, NC. Very strong temperature contrasts were present, indicating the potential for rapid deepening. Eleven inches of snow fell at Mt. Mitchell in western North Carolina. Meanwhile, sea surface temperatures in the Gulf Stream were 78° to 81°F off Cape Hatteras.

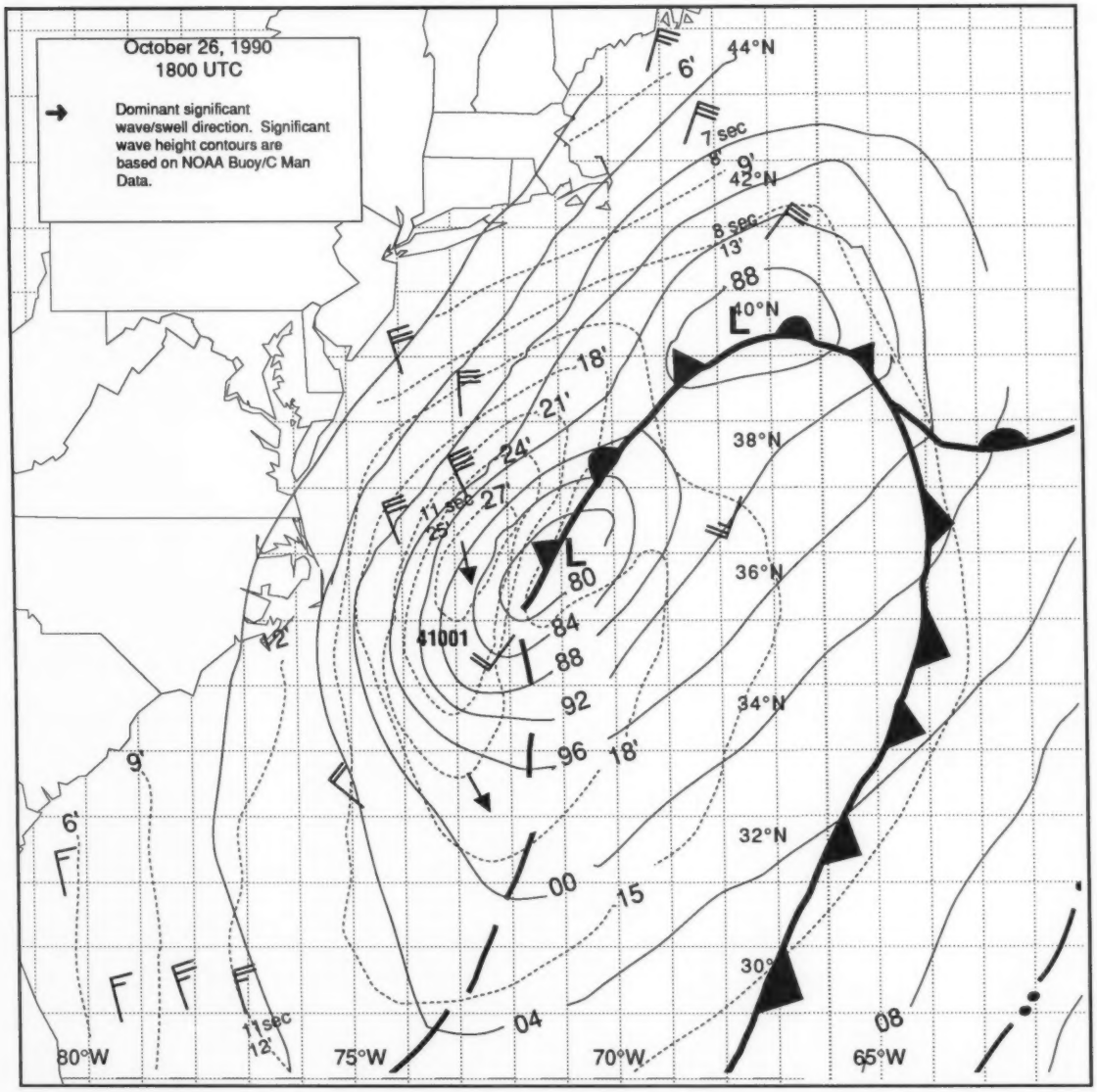
During the daylight hours of October 25, the Low's minimum pressure was near 1004 millibars, and the Outer Bank's winds were mostly 15 to 25 knots. At 6:15 p.m. (EDT) the National Weather Service issued gale warnings from Virginia Beach to the South Carolina border for 35–to 45– knot winds. This was based on a numerical forecast model, which predicted the Low to deepen moderately to 995 millibars by 7 a.m. the following day, near 35°N, 73°W. The storm deepened at a faster rate than predicted resulting in significantly stronger–than– expected pressure gradients near the coasts of North Carolina and Virginia.

The author analyzed the regional charts for October 26, 1990 using real–time synoptic data. Fortunately, the area has an excellent data network of NOAA buoys and C MAN stations. With an assist from satellite data, accurate reconstruction of the storm history is possible. The analysis also contains combined sea height data from the NOAA buoys.

Strong Winds, High Seas

During the night of October 25–26 the Low tracked east northeastward, deepening 20 millibars to 984 millibars.

By sunrise, sustained winds exceeded 40 knots from near Atlantic City to Frying Pan Shoals, off South Carolina. The Chesapeake Bridge Tunnel had hurricane velocities of 70 knots with gusts to 80 knots. Hurricane force gusts raked the entire Outer Banks and coastal waters. The ***Gypsum King*** (37.9°N, 74.6°W) reported



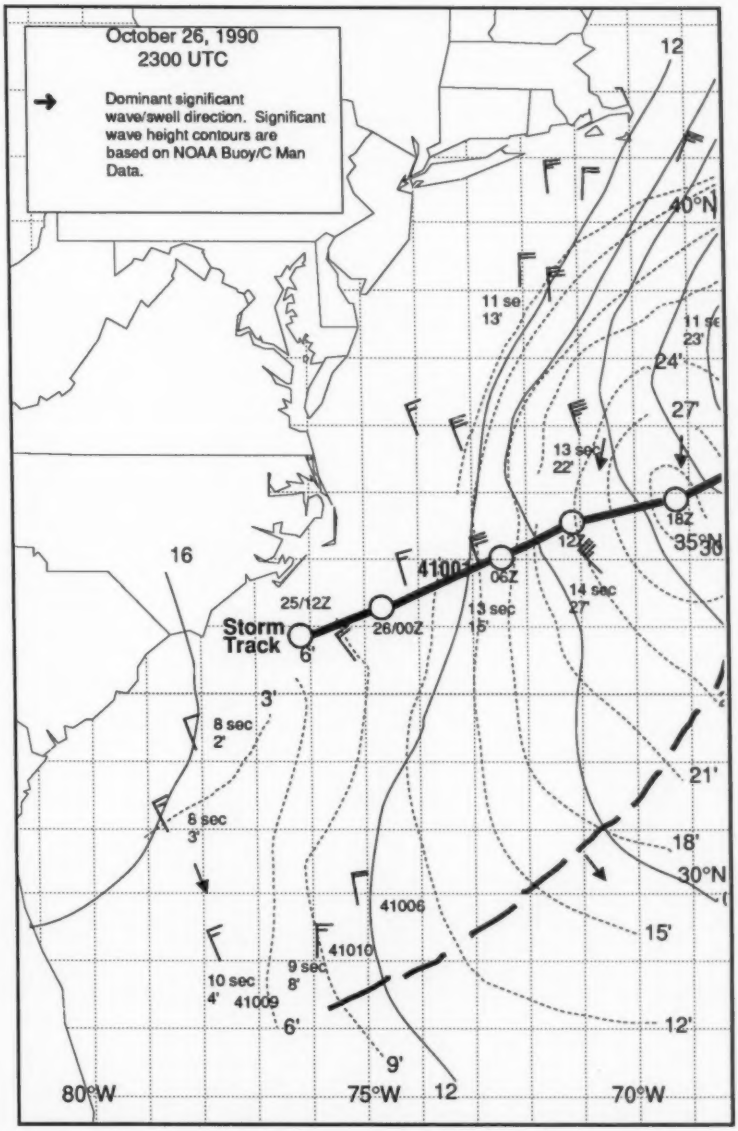
43–knot north northeasterlies at 1200 UTC. Several other vessels encountered storm force winds and rough seas in this vicinity. One ship hit 58–knot northerlies, while the *Neches* ran into 21–foot seas with a 4–second period at 1300 UTC.

Wind driven storm waves built quickly to 18 to 24 feet in the ocean northeast of Hatteras. The very short wave periods of 8 to 9 seconds contributed to major dune erosion along the Outer Banks north of Buxton.

Combined effects of hurricane force gusts, wind–whipped waves, and strong currents in Oregon Inlet made it impossible for the barge crew to avoid collision with the Bonner Bridge.

Intensification

Following occlusion, the storm maintained a generally east northeast track into the open Atlantic. (An occlusion occurs when a cold front overtakes a warm front, forcing the warmer air aloft.) The intensity of the circulation was demonstrated by impressive pres-



sure changes at Buoy 41001 (34.9°N, 73.0°W), 130 nautical miles east of Hatteras. At 1200 UTC, the pressure was 993.1 millibars. Six hours later the reading bottomed out at 981.1 millibars. By 2300 UTC, the storm accelerated seaward, and the pressure rose to 1004.8 millibars, almost a 24 millibar rise in 5 hours. Such gradients are often associated with tropical cyclones.

Satellite Display

The enhanced infrared GOES image of 1700 UTC displayed several interesting features. (See page 6.) The primary circulation center near 36°N, 72°W had an eye–like feature similar to that of a hurricane. Such a rare feature has been observed only a few times with other intense extratropical cyclones. Unlike a tropical system, however, the strongest convection was located several hundred miles away from the storm center. Layered clouds and moderate rain extended from Maine to Virginia. A strong squall line preceded a frontal band near Bermuda. Cumulonimbus clouds topping 55,000 feet caused 40– to 60–knot squalls. A new circulation developed on the tip of the occlusion near 39.0°N, 67.5°W. Five hours later this became the main storm center, entirely absorbing the former circulation near buoy 41001.

Storm Summary

This rapidly evolving storm scenario caused spectacular changes in sea conditions off the Outer Banks. Waves were only a few feet high offshore on October 25th. By sunrise the next day, seas were over 20 feet. As the day progressed, significant wave heights increased to 27 feet at buoy 41001. It is likely that isolated seas exceeded 50 feet, an extremely dangerous situation for all marine interests. The Bonner Bridge storm reminds mariners and coastal residents of an important lesson: even in this era of weather satellites and sophisticated numerical prediction models, it is sometimes not possible to accurately pinpoint the development rate of coastal storms. It is always good planning to prepare for worse than forecast conditions when a coastal low gains energy by crossing a warm ocean current.

Soviet–American Sail, 1990

LCDR Craig McLean
NOAA Corps

In the summer of 1990, American merchant marine cadets were given the opportunity to participate in the first–ever joint Soviet–American training cruise, sailing from the Soviet Union to the United States aboard the beautiful Soviet tall ship ***Druzhba****. It was a remarkable maritime experience for the American cadets.*

__Druzhba__ is a full ship, square–rigged on all three masts. Seven kilometers of running rigging pull and strain every yard and sail of the ship (left). Nearly 200 lines run to the pin and fiferails, controlling the 26 sails. The 2257–ton vessel was built in 1987, in Gdansk, Poland. She is adorned with stainless steel blocks and belaying pins, but she and her four sister ships are built along the same lines as old square riggers. Her modifications are for improved safety, such as increased compartmentation to control flooding and fire, and an enclosed upper deck which provides reserve stability at excessive angles of heel. __Druzhba__ is designed to come back from a 90 degree roll, and typically can make a forward speed equal to half of the wind speed on the beam.

The fore and the main masts terminate 49.5 meters above the surface of the ocean. Five meters below that is the top of the mizzen mast. **Druzhba** *is the Soviets' tall ship used for training cadets from the Odessa Higher Engineering Marine School. It didn't take long for the cadets to mix and Cadet Tammy Foye, who became the first woman to climb one of Druzhba's masts, meets one of the Soviet cadets upon her arrival in Odessa, USSR (below, left: photo by Joanne Flanders). One of the first, important tasks that had to be learned by both American and Soviet cadets was the names of the many lines that make up a sailing ship (below). Craig McLean was an instructor from NOAA and, except where noted, took the photographs that accompany the article.*

Only two professions in the Soviet Union require 6 years of training— a physician, and a maritime officer. Given the investment in a maritime cadet, it is not surprising that the Soviet training program focuses heavily on developing such basic tenets as seamanship and a love for the sea. No better experience can be imagined to reinforce this training than tall ship sailing.

This past summer maritime cadets from nearly every merchant marine academy in the United States were represented on what had become known as the **Soviet–American Sail, 1990**. *Maine Maritime Academy, Massachusetts Maritime Academy, the United States Merchant Marine Academy, Texas A&M* (also contributing an instructor), *California Maritime Academy*, along with several civilian American cadets and mariners journeyed to Odessa.

The sponsors of this historic experience included major supporters of tall ship sailing in the United States: the *Deep Water Alliance*, promoting maritime cooperation between the U.S. and Soviet Union, and the *U.S. Tall ship Foundation*, a steadfast proponent of tall ship training, working for the construction of an American tall ship merchant training vessel. The *National Oceanic and Atmospheric Administration (NOAA)*, supported the voyage by sending four officers from the NOAA Commissioned Corps to serve as instructors for the American cadets, and provided training and navigation materials for the journey. The Soviet sponsors were the *Odessa Higher Engineering Marine School*, and the *Black Sea Shipping Company*.

The 6500–mile journey of oceans and friendship, (the translation of druzhba is "friendship") began in Odessa, a historic maritime city at the northern edge of the Black Sea. The Odessa marine terminal pier lies at the bottom of the long and famous Potemkin Stairs. At the end of this historic anchorage, the three mast tops of ***Druzhba***, peered out over the upper decks of modern Soviet passenger ships and Black Sea ferries. Beneath this visual anachronism friends and relatives of the crew and Soviet cadets waved farewell to loved ones whom they would not see for 4 months.

The square–rigged ship departed with Soviet and American maritime cadets along with instructors trained in such technical subjects as celestial navigation, ship's stability, and hydrography. All participants willingly accepted the new challenge of diplomacy. The educational experience was multi–faceted for the American cadets, who learned tall ship sailing, and

As a diesel sailor, and never one fond of heights, it was with much trepidation that I participated in the mast and spar drills (left). Patient and very safe Soviet instructional methods helped us all develop varying degrees of proficiency in working aloft; a skill that would be necessary for every cadet throughout the voyage. Most cadets quickly got all the way to the top, while for the instructors, climbing was optional. The temptation for solitude often won over fear (below).

For Captain Richard "Red" Shannon, the former sail master of the U.S. Coast Guard Cutter ***Eagle****, this was nothing new. As the Director of Training for American cadets, he lent a degree of confidence to the American planners in that they had obtained the man who knows more about sailing tall ships than anyone in America. To the right (from left to right) are his compatriots, Captain Kovalchuck, Sailing Captain; and Captain Konstantin Kremlyanskiy, Master of* ***Druzhba****.*

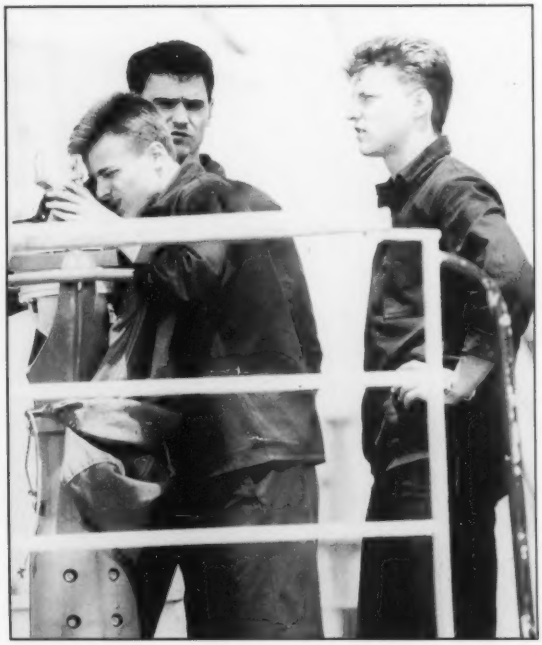
experienced being a part of a Soviet crew; they became totally immersed in another culture within the confines of a 368–foot ship.

As Vorontsov Lighthouse passed astern, the trip really began. I was invited to the quarters of two of the more experienced mariners. We sipped Russian coffee and passed around a pocket–sized English–Russian dictionary, the keystone to our conversation. We talked about common experiences. One sailor, who had worked Antarctic whaling ships, fished George's Bank at a time when I had sailed there as a scientist, to quantify the effects of his fishing.

The Soviet cadets were all from the *Odessa Higher Engineering Marine School*, and embarking upon their annual summer cruise. They made fast friends with their American roommates, sharing comfortable 12–man berthing areas boasting framed bunks, not hammocks. Baseball caps, hats, tee shirts, belt buckles, anything and everything was swapped and traded during the first few days. It was difficult to tell the Americans from the Soviets. Two days out, when all cadets were issued the working cadet jumper and trousers, it was impossible to identify the cadets by nationality. The faces simply showed youth and energy. Any face could have been my American neighbor.

Istanbul, a gracious city rich in history and culture, was our first port. Beneath the wonders of the Blue Mosque and Topkopi Palace, new friendships were forged. The goal was not so much to see Istanbul, as it was to see it together.

The Aegean Sea, where maritime exploration began thousands of years ago, was once again contributing to maritime history. It was but one of eight seas and an ocean which we would cross during this journey.



***Druzhba** is equipped with modern electronic navigation equipment which enables the watch officer to focus his attention on the safe operation of the ship. Cadets and instructors labor in the training areas of the ship with the traditional methods of instruction involving patience and sextants (left). Cadets practice their navigation skills in a separate Cadet Chartroom, complete with port and starboard gyro repeaters and six chart tables. This chartroom is located in the forward deck house away from the actual bridge. The cadets selected for tall ship training are the new initiates, not the seniors who are experiencing the conditions of the modern merchant fleet. Through this traditional instruction, the cadets are better prepared for their careers in the modern fleet.*

*In a warming world, **Druzhba** provided visible diplomacy stopping in Ceuta, Spain, the Canary Islands, Bermuda, and Baltimore. At each port, local visitors to the ship were amazed to see Soviet and American cadets working, learning, and playing together. The 4th of July (below) was celebrated in the Canary Islands with competitions between cadet watches. As the Druzhba arrives in New York City, American and Soviet Instructors pose with Soviet officers (page 15).*

Captain Konstantin Kremlyanskiy is the Master of ***Druzhba***. A big, white–haired man, he has a love for the sea and dislike of shoreside fanfare. He spoke of peace, friendship and the pleasures of sailing his beautiful ship. If sailors really are the best diplomats, Captain Kremlyanskiy is certainly among them.

The daily routine was demanding. A sea watch schedule of 12 – 4, 4 – 8, and 8 – 12 was established shortly after departure, and not broken until reaching Baltimore. American and Soviet cadets were organized into three watch sections, standing 4 hours on watch and eight hours off, to sleep, study, clean quarters, and relax. Each watch section was assigned a mast to be manned during the all–hands sail evolutions. Each maneuver requiring all–hands on deck, such as the simultaneous furling or unfurling of all ship's sails, could take place at anytime, depending upon weather changes. Otherwise, watch time was spent on safety, navigation, seamanship, and developing a thorough knowledge of the ship, her rigging, and proper execution of maneuvers.

Deck seamanship was taught with hands–on techniques with the assistance of the crew. Cadets actually performed the deck and rigging maintenance of the ship. Working aloft with crew, they learned everything from simple marlinespike seamanship to replacing "baggy–wrinkle" on the stays and other standing rigging, to protect the sails from abrasion damage.

The 8–hour daylight period between watches was often spent studying, playing ping pong, or watching Russian–dubbed American movies. Night watches would concentrate on lectures and instruction rather than drills aloft, though many were spent furling sail under the powerful electric lamps of ***Druzhba,*** when required by changes in the weather. Through this schedule and the need to work together, cadets learned the importance of responsible watch standing and accountability.

Meals of traditional Russian food were served for breakfast, lunch, evening tea, and dinner. Many meals reflected the taste of the Soviet mariner, such as Monday's breakfast of fish and boiled potatoes. Part of the education aboard ***Druzhba*** was designed to include the culinary attributes of the Soviet diet. To encourage American cadets to live within another culture, rather than selectively taste it, the trip's planners decided to change the diet very little, adding only such items as ice cream and fresh fruit.

Tall ship training is alive and well in many maritime nations. Without the U.S. Coast Guard Cutter ***Eagle,*** America would loose all vestiges of high seas tall ship training and the lasting benefits of this experience. Without the sailing experience gained aboard ***Druzhba,*** our American merchant marine cadets might never have learned the importance of the basic maritime skills.

The experience provides an appreciation for necessary seamanship skills often overlooked in the modern maritime world.

Soviet–American Sail 1990 aboard ***Druzhba*** was certainly a success. Cadets felt the accomplishment of sailing the world's most traditional maritime routes using the winds and currents instead of opposing them with machinery.

Perhaps most important, instead of standing in an air–conditioned digital bridge 30 meters above the water, they got close to the sea and tasted its salt.

Todd Sumlin

North Atlantic Hurricanes, 1990

Max Mayfield
National Hurricane Center

The 1990 Atlantic hurricane season was an active one. Of the 14 named tropical storms, 8 developed into hurricanes, which compares to the long–term average of 10 named tropical cyclones per year, 6 of which become hurricanes. However, only one 1990 hurricane (Gustav) generated maximum sustained winds greater than 100 knots. Also, many of the 1990 tropical cyclones recurved over the central Atlantic in response to a persistent upper–level trough.

The National Hurricane Center received over 100 ship reports of tropical storm force winds within 300 nautical miles of a storm center. These reports were essential in determining intensity and trends.

The relatively low U.S. damage estimate of $57 million was the result of only one tropical storm, Marco, hitting the United States. The damage was primarily caused by flooding over Florida, Georgia, South Carolina and North Carolina produced by a combination of the remnants of Marco, the remnants of Klaus and a frontal trough.

Max Mayfield is forecaster at the National Hurricane Center, Miami, Florida.

Specific locations and distances (nautical miles) normally refer to the center of the tropical cyclone. It should be noted that tropical cyclones generally cover thousands of square miles around that center and effects can be experienced many miles from it.

Lixion Avila, Bob Case, Hal Gerrish and Miles Lawrence also contributed to this report. Joan David drafted the track chart.

Hurricane Bertha

Bertha originated from a non–tropical area of low pressure near Cape Hatteras, North Carolina. This Low was detected moving southeastward on the 24th of July. By the 25th, the Low began recurving toward Florida. In retrospect, it is estimated that a tropical depression formed about 300 miles east of Daytona Beach, Florida on the 27th. The depression drifted southwestward and made a counterclockwise loop about 250 miles east–northeast of Cape Canaveral, Florida. Based on 35–knot sustained winds reported by the Russian ship ***Akademik Zavaritsky***, the depression was deemed to have reached tropical storm strength early on the 28th.

Air Force reconnaissance reports indicated Bertha reached hurricane strength early on the 29th some 450 nautical miles west southwest of Bermuda. However, strong shearing occurred and Bertha weakened, but then re–intensified again on the 30th, about 225 nautical miles northwest of Bermuda.

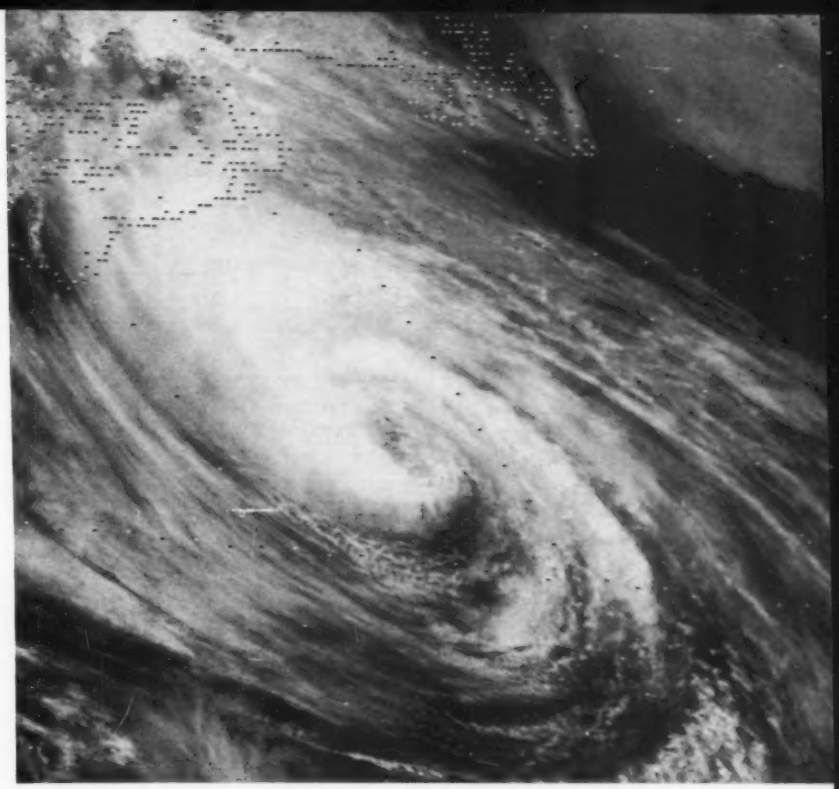
The system accelerated on the 1st of August as the center passed just west of Sable Island. Maximum sustained winds of 70 knots and a minimum central pressure of 973 millibars occurred early on the 2d. Bertha was declared extratropical later in the day with the center directly over Sydney, Nova Scotia. The weakening extratropical system continued northward over the eastern Gulf of St. Lawrence.

For most of its life, Bertha was primarily of concern to the marine community with numerous ships reporting sustained winds in the 35– to 50–knot range. A moored buoy located at 41.1°N, 61.1°W reported 56–knot winds, a significant wave height of 25 feet, and a maximum wave height of 50 feet on the 1st. The broad circulation also produced high surf along the Atlantic coast from North Carolina to Nova Scotia. Moderate beach erosion occurred along the coast of North Carolina and the Outer Banks. Bertha produced copious amounts of rainfall over Nova Scotia with storm totals in excess of 7 inches at Hunters Mountain and at Braddeck, Nova Scotia.

Nine people perished as a result of Bertha. Thirty–foot waves whipped by 78–knot wind gusts snapped the keel of the 593–foot Greek freighter ***Corazon***. Six crewmen perished while trying to abandon ship (see Mariners Weather Log, Winter 1991). A seaman was swept off the 240–foot container ship ***Patricia Star*** while attempting to secure a deck load in heavy seas. Bertha was also blamed for rip currents that drowned two people at north Florida beaches.

Hurricane Diana

Diana formed from a classical tropical wave which moved off Africa on the 27th of July and represented a typical example of developing disturbances over the Atlantic. The



Although not recommended by the National Hurricane Center, Brad Kennis rides a wave, provided by Hurricane Lili, on the 14th of October (page 16). The scene was the Hot Wax Challenge surfing contest off the Oceanic Pier at Wrightsville Beach, North Carolina. Photograph Courtesy of the Morning Star of Wilmington, NC.

Hurricane Bertha (upper right) is caught by the GOES Satellite in a visible image at 1531 UTC on the 1st of August, south of Nova Scotia.

Monthly Summary of 1990 Atlantic Tropical Cyclones

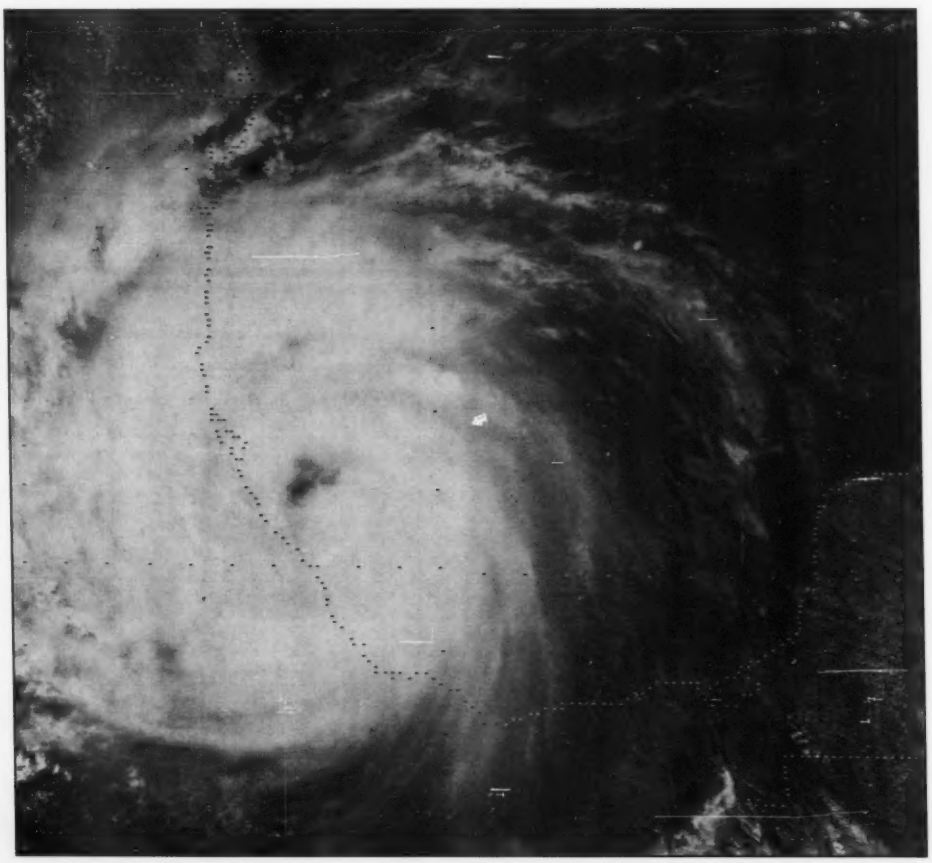
	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Tropical Depressions	1	0	0	0	1	0	0	2
Tropical Storms	0	0	2	3	0	1	0	6
Hurricanes	0	0	1	2	2	3	0	8
Total	1	0	3	5	3	4	0	16

(Tropical cyclones are assigned to the month in which they first became a tropical depression)

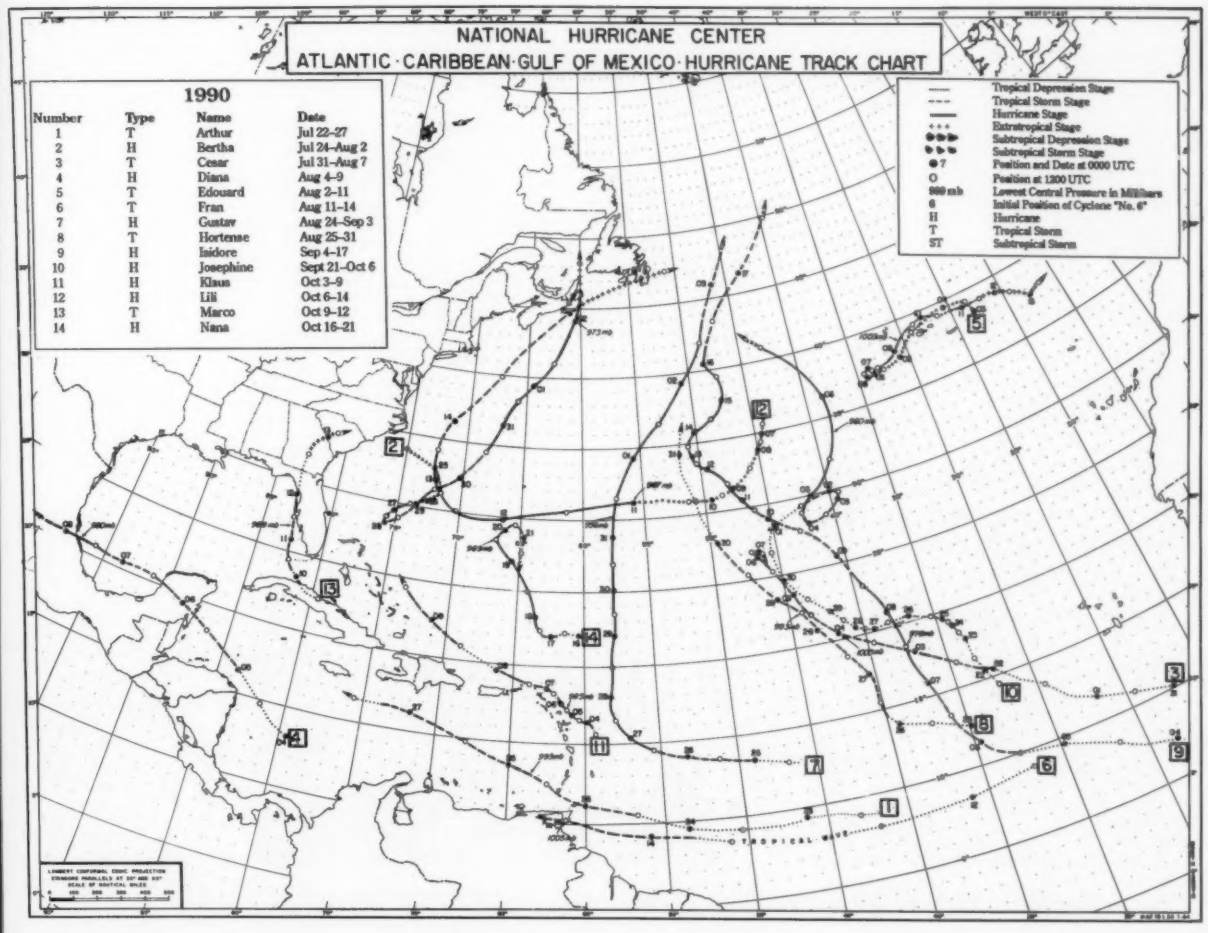
wave moved westward through the Windward Islands accompanied by a large area of thunderstorms, but without developing a closed circulation. On the 4th of August, satellite images indicated cyclonic rotation in the low clouds and deep convection covering a large portion of the western Caribbean, suggesting that a tropical depression was forming near the eastern tip of Honduras. That was confirmed by limited surface observations and by an Air Force plane, which, indeed, found an incipient 1008–millibar center later that day.

The depression quickly reached tropical storm intensity and crossed the Yucatan Peninsula. Diana strengthened rapidly after moving away from the Yucatan into the Bay of Campeche. The minimum central pressure was 980 millibars and maximum sustained winds were 85 knots just prior to landfall near Tuxpan, Mexico.

According to an unofficial report from an amateur radio operator, the total number of deaths in Mexico associated with Diana was



This high resolution GOES image was taken as Hurricane Diana approached the Mexican coast at about 1700 UTC on the 7th of August. The hurricane was near its peak intensity when it made landfall near Tuxpan, Mexico, and caused extensive loss of life and damage to the area. The coastal town of Tamiahua was directly hit by the hurricane. Most of the damage was produced by torrential rains which triggered mudslides and flooding.


NATIONAL HURRICANE CENTER
ATLANTIC·CARIBBEAN·GULF OF MEXICO·HURRICANE TRACK CHART
1990
Number Type Name Date
1 T Arthur Jul 22–27
2 H Bertha Jul 24–Aug 2
3 T Cesar Jul 31–Aug 7
4 H Diana Aug 4–9
5 T Edouard Aug 2–11
6 T Fran Aug 11–14
7 H Gustav Aug 24–Sep 3
8 T Hortense Aug 25–31
9 H Isidore Sep 4–17
10 H Josephine Sept 21–Oct 6
11 H Klaus Oct 3–9
12 H Lili Oct 6–14
13 T Marco Oct 9–12
14 H Nana Oct 16–21
Tropical Depression Stage
Tropical Storm Stage
Hurricane Stage
Extratropical Stage
Subtropical Depression Stage
Subtropical Storm Stage
●7 Position and Date at 0000 UTC
O Position at 1200 UTC
980 mb Lowest Central Pressure in Millibars
6 Initial Position of Cyclone "No. 6"
H Hurricane
T Tropical Storm
ST Subtropical Storm
TROPICAL WAVE

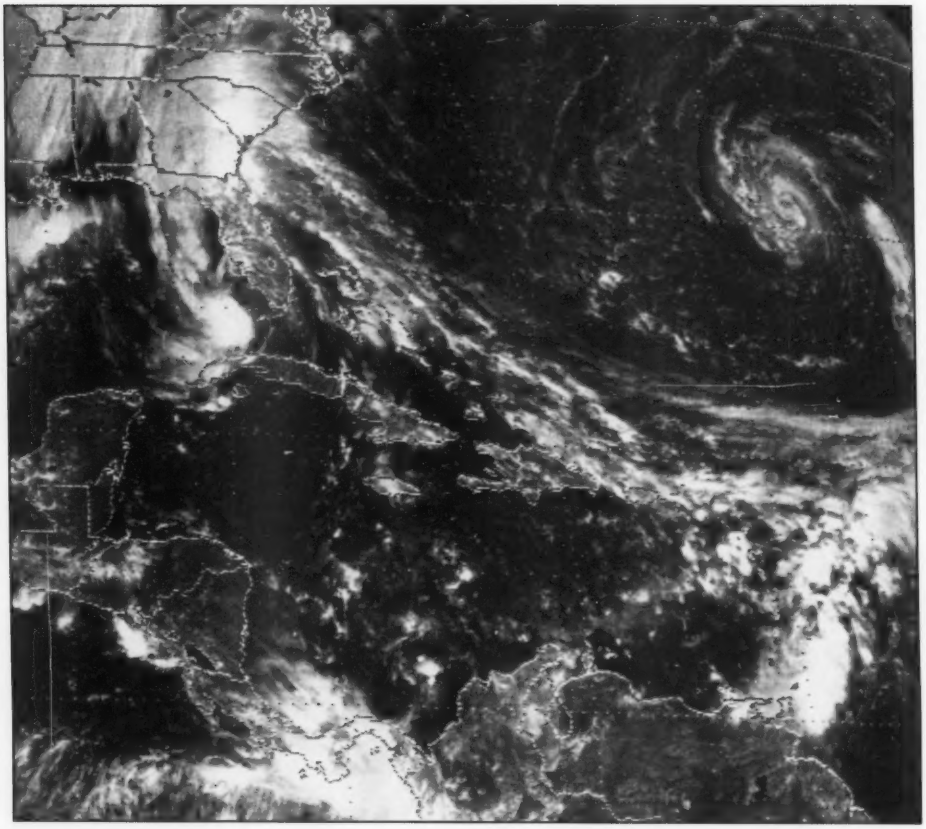
estimated at 96. The hurricane caused extensive damage to property, agriculture and roads in mountainous areas in the states of Hidalgo and northern Veracruz. The coastal town of Tamiahua was directly hit by the hurricane. Most of the damage was produced by torrential rains which triggered mudslides and flooding.

Hurricane Gustav

The tropical wave that spawned Gustav moved off the northwest coast of Africa on the 18th of August, and became embedded within the ITCZ on its westward journey across the tropical Atlantic. It didn't begin strengthening until late on the 23d, and is estimated to have become a tropical depression about 800 nautical miles east of Barbados on the 24th.

Gustav reached tropical storm strength about 600 nautical miles east of Barbados on the 25th. It continued the same general motion under the influence of weak ridging to the north. There was some concern that a cold low to the northwest of Gustav would inhibit development, however, the low had little impact and Gustav reached hurricane strength 240 nautical miles east–northeast of Barbados on the 26th. The first reconnaissance aircraft fix in Gustav had 65–knot winds at the 1500–foot flight level with 70–knot winds estimated at the surface on the 26th. However the ridge to the north was breaking down and Gustav responded by taking a gradual northwestward and then northward turn, with the center of the system bypassing the Lesser Antilles 180 nautical miles to the east. Aircraft reconnaissance reports indicated that Gustav reached its minimum central pressure of 956 millibars with maximum sustained winds of 105 knots while centered about 400 nautical miles east–southeast of Bermuda.

Late on the 31st, an upper trough west of the system imparted a northeastward motion to Gustav, and on the 1st of September, Gus-



The GOES visible image shows Subtropical Storm Lili over the open Atlantic, while Tropical Storm Marco lurks off the southwest coast of Florida. This photograph was taken at about 1600 on the 10th of October. Marco moved to just a few miles west of Bradenton Beach the following day and continued to hug the coast, with much of its circulation over the St. Petersburg area.

tav began merging and interacting with a frontal zone to the north, which started the weakening process. The ***Galion***, a vessel of French registry, appears to have gone through or near the edge of the eye with 70–knot winds reported on the 2d. Gustav accelerated toward the northeast on the 3d, and was declared extratropical on that day. METEOSAT satellite imagery showed that the remnants of Gustav passed less than 200 nautical miles to the south of Iceland.

Hurricane Isidore

Isidore developed from a vigorous tropical wave, which moved off the African coast on the 3d of September. Due to the time of the year and the location, it appeared for a while that the system was going to be a typical westward–moving Cape Verde hurricane. However, a persistent mid–level trough in the central Atlantic caused the storm to move in a general north–northwest course over open waters.

The wave developed into a tropical depression on the 4th, strengthened steadily to a tropical storm the next day, and to a hurricane on the 7th. Based on satellite estimates, Isidore reached its maximum intensity on the 7th when maximum sustained winds hit 85 knots and minimum central pressure dipped to 978 millibars.

The hurricane encountered strong upper–level winds induced by the same trough which was steering it northward. Due to the strong shearing, Isidore was downgraded to tropical storm status on the 8th. However, an upper low developed within the trough and moved southward, producing a favorable environment for Isidore to reintensify. An eye developed within a circular mass of convection and once again the system was upgraded to a hurricane, until it moved over cooler waters and weakened several days later. Isidore was absorbed by a large extratropical low on the 17th north of 50°N.

Hurricane Josephine

Josephine originated from a tropical wave,on the 16th of September and became a tropical depression on the 21st. The depression immediately turned northward in response to a deep low over the northeast Atlantic. During the next few days the surface low weakened,

and by the 24th surface high pressure began building to the north of the depression. The depression then turned toward the west and strengthened to a tropical storm. However, a strong upper–level trough produced shearing over the storm on the 25th and Josephine weakened to depression strength by the 26th.

By the 30th, Josephine turned toward the north and northeast into the wake of a weak eastward–moving trough. The trough was too weak to capture the depression, and by the 2d of October it became readily apparent that the next high pressure center, which had moved off the Canadian Maritimes, had begun to block Josephine's escape to the northeast. Josephine reintensified to tropical storm strength as the high pressure forced the storm into a 360–degree clockwise turn during the following three days.

By the 4th of October, Tropical Storm Josephine, located in a favorable upper–outflow pattern, strengthened to hurricane force. However, the following day, a frontal wave began to form in the trough just to the north of the hurricane. The lowest satellite–estimated pressure of Josephine was 980 millibars with associated winds of 75 knots. On the 6th, Josephine became an extratropical low–pressure center as it continued to move northward of a developing mid–latitude storm. This newly–formed system later developed tropical characteristics and became Hurricane Lili.

Hurricane Klaus

Klaus originated from a tropical wave that moved off the coast of Africa on the 27th of September. The wave moved across the Atlantic for several days, and finally became a tropical depression on October 3 about 100 miles east of Dominica. The system drifted slowly northwestward for 3 days and reached hurricane strength on the 5th. At that time, the center was at its point of closest approach to the Leeward Islands— about 25 nautical miles east of Antigua and, shortly thereafter, about 10 miles east of Barbuda.

Tropical Cyclone Winds

(Ship encounters of 50 Knots or more)

Tropical Cyclone	Ship Name	Date Mo/Da	Time UTC	Position LatN LonW	Wind (kn) Dir/Speed	Pressure (mb)
Bertha	*Pacglory*	7/29	1200	30.6 69.0	180/52	1007.2
	Pacglory	7/29	1800	30.1 69.7	180/50	1006.0
	Star Eagle	7/30	1200	32.9 67.3	230/50	996.0
	Star Eagle	7/30	1800	32.7 67.9	270/50	1004.5
	Howell Lykes	7/31	1200	37.7 71.8	320/58	1009.0
Gustav	*Trinidad & Tobago*	8/27	0000	16.2 56.3	080/63	1007.7
	Galion	9/01	1200	41.3 56.9	070/50	
	Galion	9/02	0000	41.7 53.4	030/70	1014.5
	Budowlany	9/02	1200	37.7 48.6	210/58	
	Galion	9/02	1800	41.8 49.8	280/70	1007.5
	Galion	9/03	0000	41.7 47.9	270/50	1017.0
Isidore	*African Highway*	9/13	1200	30.6 50.2	240/62	1011.5
Josephine	*Virgo*	10/05	1200	30.9 38.2	190/60	1003.2
Lili	*Fichtelberg*	10/06	1200	35.9 47.9	330/50	1003.0
Nana	*Sealift Mediterranean*	10/18	1200	23.6 62.5	190/58	1013.0

Klaus reached peak intensity on the 5th with maximum sustained winds of 70 knots and minimum central pressure of 985 millibars. Although Klaus moved close to the Leeward Islands, there were no observations of sustained tropical storm–force winds, due to the frequent shearing conditions that caused most of the deep convection and strong winds to be located north and east of the circulation center.

On the 6th, Klaus weakened to a tropical storm and, by early on the 8th, was north of the Mona Passage when it fell to a tropical depression in response to persistent strong shearing.

Klaus regained deep convection near its center and also tropical storm status later on the 8th. By this time, a secondary low pressure center was noted at mid–atmospheric levels over eastern Cuba. This low drifted westward and gradually worked its way to the surface.

By late on the 9th, Klaus had dissipated and this new low became the dominant feature, which eventually developed into Tropical Storm Marco. The remnants of Klaus, interacting with Marco and a slow–moving frontal trough, were responsible for heavy rainfall across portions of the southeastern United States. Four drowning deaths, related to the remnants of Klaus, were reported from South Carolina when a dam burst and swept away a car and its occupants. In addition, seven deaths,related to the heavy rains associated with Klaus, were confirmed on the Caribbean island of Martinique.

Hurricane Lili

While Hurricane Josephine was moving counter clockwise around a cold low aloft, several hundred miles southwest of the Azores on the 5th of October, the cold low was working its way down to the surface. The Low was classified a subtropical storm on the 6th when ship reports indicated that the strongest winds were well removed from the center. Satellite imagery indicated that the system gradually acquired tropical characteristics during the next few days and became hurricane Lili on the 11th, with a minimum central pressure of 987 millibars and maximum sustained winds of 65 knots. The center passed 120 miles to the south of Bermuda.

On the 13th, Lili weakened to a tropical storm, as the center passed less than 170 miles to the east southeast of Cape Hatteras, North Carolina. Lili accelerated northeastward, and its speed was in excess of 35 knots when the system skirted Nova Scotia as an extratropical storm and passed over the extreme southeastern portion of Newfoundland.

Hurricane Nana

The 14th named system of the season developed from a vigorous tropical wave, which moved over the Cape Verde Islands on the 7th of October. The wave became a tropical depression about 350 miles northeast of Puerto Rico on the 16th.

This depression intensified rapidly and reached hurricane status late on the 17th. Nana attained a minimum central pressure of 989 millibars with maximum sustained winds of 75 knots on the 19th, and posed a brief threat to Bermuda. However, an impulse of upper level westerlies moved across the hurricane and separated the convection from its low level center. Consequently, Nana weakened to a tropical depression and drifted in a southerly direction, steered by the low level flow until it dissipated on the 21st.

1990 Atlantic Hurricane Season Statistics

No.	Name	Class [1]	Dates [2]	Maximum sustained wind (kn.)	Lowest pressure (mb.)	U.S. damage ($ millions)	Deaths
1.	Arthur	T	22 – 27 Jul.	60	995		
2.	Bertha	H	24 Jul.– 2 Aug.	70	973	9	
3.	Cesar	T	31 Jul.– 7 Aug.	45	1000		
4.	Diana	H	4 – 9 Aug.	85	980		96
5.	Edouard	T	2 – 11 Aug.	40	1003		
6.	Fran	T	11 – 14 Aug.	35	1005		
7.	Gustav	H	24 Aug. – 3 Sep.	105	956		
8.	Hortense	T	25 – 31 Aug.	55	993		
9.	Isidore	H	4 – 17 Sep.	85	978		
10.	Josephine	H	21 Sep. – 6 Oct.	75	980		
11.	Klaus	H	3 – 9 Oct.	70	985		11
12.	Lili	H	6 – 14 Oct.	65	987		
13.	Marco	T	9 – 12 Oct.	55	989	57	7
14.	Nana	H	16 – 21 Oct.	75	989		

[1] T: tropical storm, wind speed 34 – 63 kn.

[2] H: hurricane, wind speed 64 kn or higher.
Dates begin at 0000 UTC and include tropical depression stage.

Tossing this trash overboard could leave death in your wake.

Throwing a few plastic items off a boat may seem harmless enough. What's one more six-pack ring, plastic bag, or tangled fishing line?

Actually, it's one more way a fish, bird, seal, or other animal could die.

Fish, birds, and seals are known to strangle in carelessly discarded six-pack rings. Sea turtles eat plastic bags – which they mistake for jellyfish – and suffer internal injury, intestinal blockage, or death by starvation.

Other plastic trash can be dangerous, too. Birds are known to ingest everything from small plastic pieces to plastic cigarette lighters and bottle caps.

Birds, seals, sea turtles, and whales die when they become trapped in old fishing line, rope, and nets.

Plastic debris also can foul boat propellers and block cooling intakes, causing annoying – sometimes dangerous – delays and causing costly repairs.

So please, save your trash for proper disposal on land.

That's not all you'll be saving.

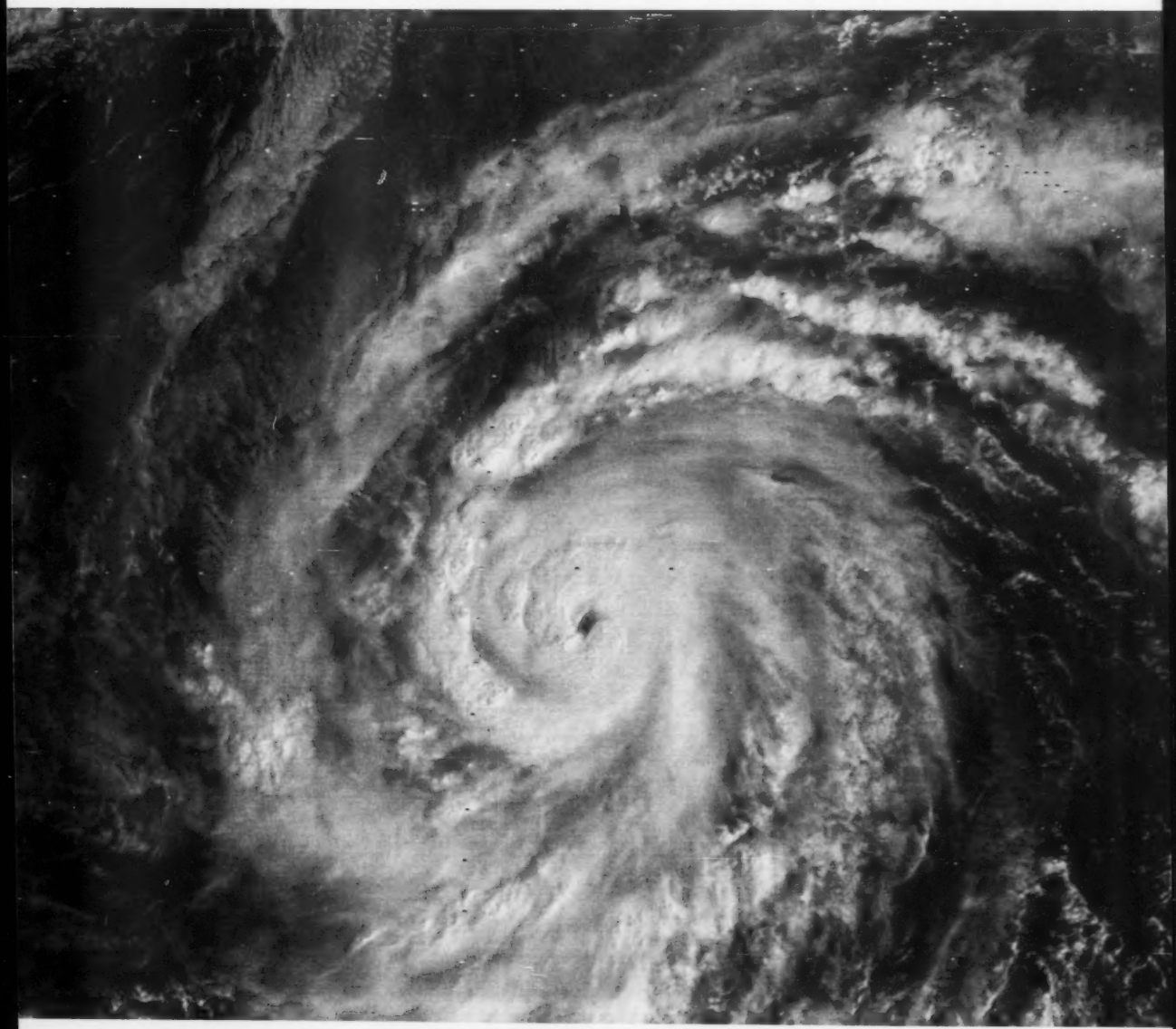
To learn more about how you can help, write: Center for Marine Conservation, 1725 DeSales Street, N.W., Suite 500, Washington, D.C. 20036.

A public service message from:
The Center for Marine Conservation
The National Oceanic and Atmospheric Administration
The Society of the Plastics Industry

Eastern North Pacific Hurricanes—1990

Lixion Avila
National Hurricane Center

This year featured Hernan and Trudy— among the strongest hurricanes ever observed in this basin, and Alma— the earliest named tropical cyclone of record for the eastern North Pacific.



The Eastern North Pacific produced a record number of hurricanes in 1990, marked by several very strong ones. The 20 named tropical cyclones were two below the record but four more than the long–term average. Sixteen of those named storms reached hurricane intensity.

Records for this basin are suspect prior to the implementation of weather satellites in 1966. Also, there are generally no direct measures of storm strength in this region. Intensity estimates are derived from empirical relationships based upon cloud characteristics revealed in satellite imagery. These values should not be taken as being precisely correct. Ship reports from merchant and fishing vessels are invaluable.

The origins of all this year's storms and hurricanes were apparently associated with westward moving African waves. With the exception of Marie and Polo, all these systems developed between 5° N and 15° N, east of the longitude of Baja California— their most favored area for cyclogenesis. After their development, eastern Pacific tropical cyclones generally move on a west to northwest track and dissipate over the cooler waters without affecting land. Rachel was the only system to make landfall.

Specific locations and distances (nautical miles) normally refer to the center of the tropical cyclone. It should be noted that tropical cyclones generally cover thousands of square miles around that center and effects can be experienced many miles from it. Bob Case, Hal Gerrish, Miles Lawrence and Max Mayfield also contributed to this report.

Lixion Avila is a Hurricane Forecaster at the National Hurricane Center in Miami, Florida.

Hurricane Alma

Alma, the earliest eastern Pacific hurricane on record, originated from a tropical wave which moved off the African coast on the 29th of April. The wave showed very little convective activity until it moved just to the south of Panama. The system then became better organized and was upgraded to a tropical depression on the 12th of May about 480 nautical miles south of Acapulco, Mexico. The depression developed slowly with maximum sustained winds reaching 75 knots on the 16th. The hurricane then gradually weakened as it moved over cooler waters and into a strong shear environment.

Hurricane Boris

The second tropical depression formed about 350 nautical miles south of Acapulco, Mexico on June 2. It became Tropical Storm Boris about 435 nautical miles southwest of Manzanillo, Mexico on the 4th, and was upgraded to a hurricane the next day, when estimated maximum sustained winds reached 80 knots around a 977–millibar central pressure. A weakening process began while Boris was moving over increasingly cooler waters. It dissipated a couple of days later.

A 31–foot sailboat named the ***Azure Dream*** reported 70–knot winds, a 982–millibar pressure and sails damaged in Boris on the 6th. Moisture from the remnants of Boris spread over the southwestern U.S. and contributed to some locally heavy rains. This was the wettest June for San Diego, California, since records began in 1850.

Hurricane Elida

The origin of this storm can possibly be traced back to a tropical wave that moved from Africa on the 10th of June. However, it was not until the 26th that the system became a tropical depression in the eastern Pacific. It was quickly upgraded to a tropical storm that day and to a hurricane on the 28th, when Elida moved directly over Socorro Island with 70 knot winds and a 990–millibar minimum pressure. A total of 3.7 inches of rainfall was reported there as well as some glass breakage. The ***Marine Reliance***, some 75 nautical miles north northwest of the center, reported 41–knot winds on the 26th. The ***Dole Ecuador***, located a little less than 300 miles east northeast of the center, reported a 37–knot wind on the 27th.

Monthly Summary of 1990 Tropical Cyclones

	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Tropical Depressions	0	1	1	1	1	0	0	4
Tropical Storms	0	2	0	0	1	1	0	4
Hurricanes	1	2	4	3	4	2	0	16
Total	1	5	5	4	6	3	0	24

(Tropical cyclones are assigned to the month in which they first became a tropical depression.)

Hurricane Fausto

A tropical depression formed about 250 nautical miles south southwest of Acapulco, Mexico, on the 6th of July and became Tropical Storm Fausto 1 day later. A weak eye developed and the system was upgraded to a hurricane with estimated 75–knot winds, some 270 miles south of Cabo San Lucas, Mexico. Fausto moved near Socorro Island producing 4 inches of rain, tropical storm force winds and a 996.2–millibar pressure. An unnamed vessel reported winds of 36 knots about 180 nautical miles from the center at 0000 UTC on the 8th. The ***Nedlloyd van Lindschoten*** observed southwesterly winds of 35 knots at 0000 UTC on the 9th.

Fausto was downgraded to a tropical storm about 350 nautical miles west of Cabo San Lucas, Mexico.

Hurricane Genevieve

Genevieve was upgraded to a tropical depression on the 11th of July. The depression moved toward the west northwest and gradually strengthened to a tropical storm on the same day. It reached hurricane status on the 13th, while passing very near Socorro Island where a 992.1–millibar pressure and tropical storm force winds were reported prior to equipment failure.

Genevieve reached hurricane strength, with estimated 90 knot winds, and turned toward the northwest by the 16th, moving into an area of strong shear. The hurricane decreased to a weakening tropical storm in 24 hours.

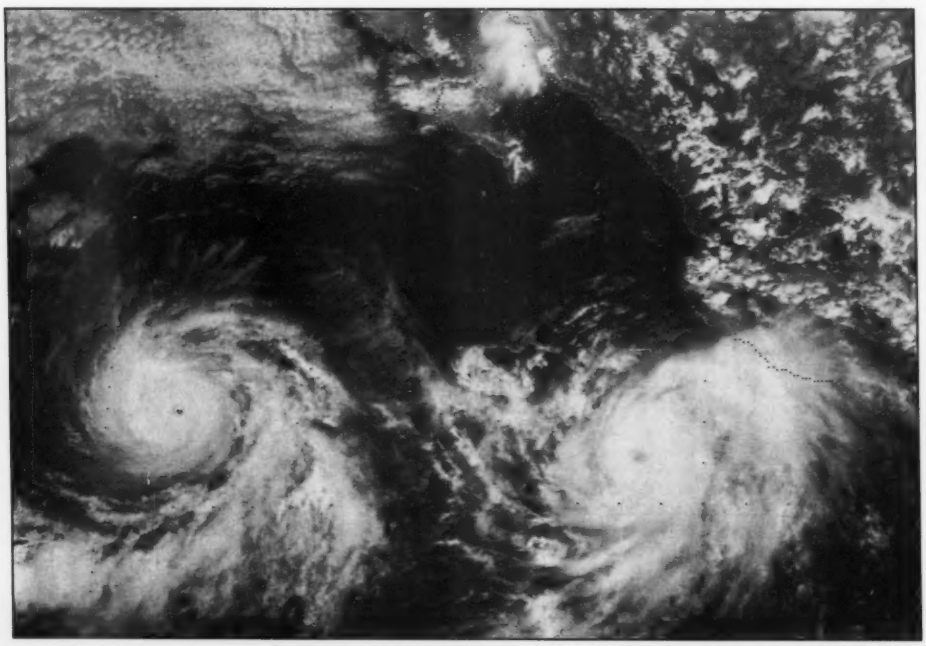
Hurricane Hernan

An African wave moved across Central America on the 15th of July, and organized into a tropical depression about 490 nautical miles southwest of Acapulco, Mexico on the 19th.

Its development was questionable due to the proximity to a trailing depression embedded in a more favorable environment for intensification. Ultimately, both developed. The first became Hernan and the trailing depression became Iselle.

Tropical Storm Hernan reached hurricane status on the 21st and remained in relative close proximity to Iselle for several days. Hurricane Hernan continued strengthening to become one of the strongest hurricanes in recent history in the eastern Pacific. Although no direct measurements were made, highest intensity estimates from satellite imagery were 135 knots with a corresponding minimum central pressure of 928 millibars on the 23d. Those intensity estimates were the same as those made for Hurricane Max (1987), which was credited as being the strongest hurricane of record in the eastern North Pacific to that date.

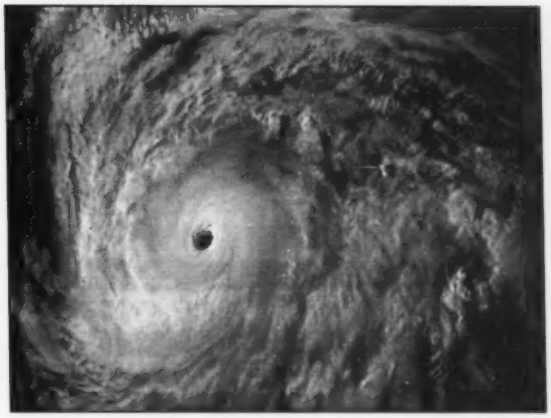
On the 24th of July, unen-



Hurricane Trudy (page 24) was possibly the most intense hurricane to ever roam the eastern North Pacific Ocean. The photograph was shot at about 1530 UTC on the 19th of October, when winds were estimated at near 135 knots. At right, Hurricanes Hernan and Iselle (right) were caught at about 2000 UTC on the 23d of July. Hernan generated winds estimated at 135 knots. It was, along with Trudy, one of the two strongest storms in the eastern North Pacific records.

hanced infrared satellite imagery revealed a concentric eyewall pattern with one eyewall inside a larger eyewall. Concentric eyewalls have been observed on satellite imagery and radar displays in intense hurricanes in the Atlantic, but they are rare. This is the first time that such a phenomenon has been clearly observed on satellite imagery at the NHC for an eastern North Pacific tropical cyclone.

Hernan was a hurricane for slightly over 6 days with estimated winds of 100 knots or higher for 4 days.



Hurricane Marie (left) is near peak intensity in this shot taken at about 0100 UTC on the 11th of September. Marie's winds reached an estimated 125 knots and a ridge to the north kept it on a westerly track. Marie was the only hurricane to move into the central North Pacific this season.

Hurricane Iselle

The African wave which produced Iselle became active several hundred miles southeast of Acapulco on the 21st of July resulting in a tropical depression near 10° N, 96°W. In spite of its proximity to Hernan, the depression intensified gradually to storm strength, and reached hurricane status on the 22d. By the 25th, the winds were estimated to be 105 knots with an associated minimum pressure of 958 millibars. Iselle also moved very close to Socorro Island. That island reported a 60 knot sustained wind, a 992.1–millibar pressure, and heavy rain on the 25th.

Hurricane Julio

Julio became a depression on the 17th of August, about 350 nautical miles south of Acapulco, Mexico. It moved west–northwestward to westward from its inception to its demise on the 24th. Julio became a storm on the 18th and a hurricane on the 19th. It is estimated to have reached maximum intensity on the 21st with 100–knot winds and a 960–millibar surface pressure. It weakened to a storm on the 23d and to a depression on the 24th.

Hurricane Kenna

Kenna originated from the same African wave that spawned Fran over the eastern Caribbean. Fran's remnants were tracked into the eastern Pacific where a tropical depression formed on the 21st of August. The depression, following in the wake of Julio, reached tropical storm status by the 22d and hurricane strength by the 25th, with estimated 980–millibar pressure and 75–knot winds. During the weakening stage, the ***Gulf Ideal*** observed 35 knots near the center of Kenna at 1800 UTC on the 29th.

Hurricane Lowell

An African wave organized into a tropical depression on the 23d of August. The tropical depression moved west–northwestward and became Tropical Storm Lowell, about 190 miles south southwest of Puerto Vallarta, Mexico, on the 25th. Lowell reached minimal hurricane strength about 250 miles southwest of Cabo San Lucas 2 days later.

As the deep convection weakened, Lowell was downgraded to a tropical storm on the 28th.

Hurricane Marie

On the 7th, a tropical depression formed about 570 nautical miles west southwest of Clarion Island. That location was somewhat west of where tropical cyclones normally form in the eastern Pacific. Marie became a tropical storm on the 8th, and strengthened to its estimated peak intensity of 125 knots on the 11th. A building ridge to the north kept Marie away from cool waters. Consequently, the hurricane moved west of 140° W threatening the Hawaiian Islands. However, the system turned toward the southwest away from those islands and dissipated. Marie was the only hurricane to move into the central Pacific from the eastern Pacific this season. Buoy 5100 located near 17.5°N, 152.9°W reported sustained 35–knot winds on the 18th.

Hurricane Norbert

Norbert began as a tropical depression on the 10th of September, about 660 miles south southwest of Cabo San Lucas, Mexico. The system reached tropical storm status later on the same day, but remained poorly organized until the 12th, when the storm interacted with Tropical Depression Eighteen–E. A classical Fujiwara interac-

tion occurred when the two systems were located only about 140 nautical miles apart, with the two centers rotating around each other. Finally, the depression was absorbed by Norbert, which then strengthened.

Norbert became a minimal hurricane on the 14th, and developed an eye for a short period of time on the 15th. The maximum wind of 48 knots was observed by an unnamed ship, about 60 nautical miles from the storm's center at 0600 UTC on the 11th. Norbert weakened to a tropical depression and then dissipated on the 19th over cool waters.

Hurricane Odile

Odile was first tracked in the eastern Pacific Ocean as an area of disturbed weather triggered by an African wave located several hundred miles south of Acapulco, Mexico. It became a tropical depression on the 23d of September, reached tropical storm strength on the 24th, and became a hurricane on the 25th. The next day it is estimated to have reached its peak intensity with 125–knot sustained winds and a 935–millibar central pressure.

Odile maintained 125–knot winds for 24 hours and then began to weaken, while gradually turning more northwestward in response to a slight weakness in the high pressure ridge. By the 28th, the hurricane was over cool waters and weakened as rapidly as it had earlier intensified.

Hurricane Polo

The southern portion of a convectively–active African wave which triggered Isidore in the Atlantic, continued its trek across the Caribbean and showed signs of development over the Bay of Campeche. An Air Force reconnaissance aircraft flying into the system could not locate a circulation center but an area of strong deep convection moved onshore along the Mexican coast and then moved westward for the following week.

After several diurnal convective outbursts, the system organized into a tropical depression near 140°W on the 28th of September and rapidly intensified into a minimal hurricane. Once Polo reached hurricane status it was destroyed quickly by strong wind shear in the vertical.

Hurricane Trudy

Trudy was a hurricane for 11 days while traveling a little more than 1200 nautical miles over the eastern Pacific. The tropical wave that became Trudy could be identified as early as the 30th of September, near the African coast. However, the wave did not show signs of

Tropical Cyclone Winds
(Ship encounters of 35 knots or more)

Tropical Cyclone	Ship Name	Date Mo/Da	Time UTC	Position LatN LonW	Wind (kn) Dir/Speed	Pressure (mb)
Boris	**Azure Dream**	6/6	0900	20.0 115.0	070/70	982.0
Douglas	**Hansa Bremen**	6/20	1800	17.1 103.6	070/44	
Elida	**Marine Reliance**	6/26	2200	17.1 107.0	080/41	1003.0
	Dole Ecuado	6/27	2300	19.2 105.3	120/37	1010.5
Fausto	**Unnamed**	7/8	0000	20.0 106.0	130/36	1008.0
	Nedlloyd van Lindschoten	7/9	0000	16.5 106.8	230/35	1007.5
Kenna	**Gulf Ideal**	8/29	1800	21.9 135.2	070/35	1013.5
Norbert	**Unnamed**	9/11	0600	11.9 111.4	260/48	1009.0
	Unnamed	9/11	1200	11.9 112.5	250/37	1006.5
	Sugar Islander	9/11	1800	12.0 114.0	230/35	1010.5
Trudy	**Makhtoum-Kouli**	10/18	0600	11.4 104.3	250/35	1008.6
	Maple Ace	10/18	1800	12.0 105.0	220/45	1005.0
	Maple Ace	10/19	1800	10.0 110.0	225/40	
	ELDY	10/25	0000	16.0 117.0	290/35	1002.0

development until the 16th of October, when a tropical depression formed several hundred miles south of Acapulco, Mexico.

The depression developed rapidly and in less than 36 hours Trudy was a powerful hurricane with 135–knot winds and a 925–millibar minimum pressure, according to satellite estimates. Trudy was at least as intense as Hurricane Max of 1987 and Hurricane Hernan of this season. Trudy may have been the strongest eastern Pacific hurricane since wind estimates have been available from satellite images.

An upper level trough located to the north forced Trudy to drift northward for a couple of days, increasing the risk of hurricane conditions to residents of Baja California. This same trough created an unfavorable environment, which weakened the hurricane considerably. As the trough was replaced by a ridge, Trudy resumed a westward motion and reintensified, developing an unusually large eye of nearly 50 nautical miles in diameter.

Another deep trough approached and pulled the hurricane northward, shearing it at the same time. Trudy dissipated on the 1st of November but the middle–level moisture was advected northeastward over northern Mexico and the southwestern United States.

Socorro Island reported hurricane force winds for more than 7 hours. The winds on that island reached 105 knots with gusts to 115 knots and a surface pressure of 995.3 millibars. These reports were received via ham radio and apparently were confirmed. However, these winds occurred when satellite wind estimates were only 70 knots and the hurricane was located about 80 miles south southwest of Socorro, so their authenticity remains somewhat in doubt. The ***Maple Ace*** reported 45 knots about 75 miles from the center at 1800 UTC on the 18th. Two other ships, ***Makhtoum–Kouli*** and ELDY reported tropical storm force winds.

Hurricane Vance

A tropical depression formed about 350 nautical miles south southeast of Acapulco. The depression paralleled the west coast of Mexico from the 21st through the 26th. It became a tropical storm on the 23d and a hurricane on the 25th. Vance peaked on the 26th with maximum sustained winds estimated at 85 knots and a minimum central pressure estimated at 975 millibars.

Vance was centered only 250 nautical miles south of the southern tip of the Baja peninsula when a ridge of high pressure blocked its forward motion and the center moved in a small loop for two days. Vance began to weaken on the 27th as a result of strong shearing conditions and also probably by being located over waters that were cooled by upwelling caused by Trudy a few days earlier, and by Vance itself. It dissipated late on the 31st.

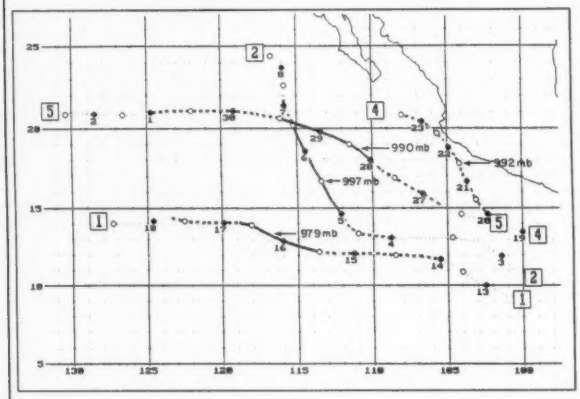
1990 Eastern North Pacific Named Tropical Cyclones

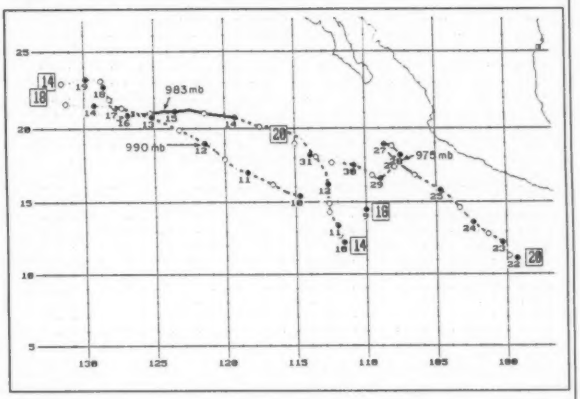
No.	Name	Class[1]	Dates[2]	Maximum sustained wind (knots)	Lowest press. (mb)	U.S. damage ($millions)	Deaths
1	Alma	H	12 – 18May	75	979		
2	Boris	H	2 – 8 Jun	80	977		
3	Cristina	T	8 – 16 Jun	55	994		
4	Douglas	T	19 – 23 Jun	55	992		
5	Elida	H	26 Jun – 2 Jul	75	990		
6	Fausto	H	6 – 12 Jul	90	979		
7	Genevieve	H	10 – 18 Jul	90	970		
8	Hernan	H	19 – 31 Jul	135	928		
9	Iselle	H	20 – 30 Jul	105	958		
10	Julio	H	17 – 24 Aug	100	960		
11	Kenna	H	21 – 30 Aug	75	980		
12	Lowell	H	23 Aug – 1 Sep	65	986		
13	Marie	H	7 – 21 Sep	120	944		
14	Norbert	H	10 – 19 Sep	70	983		
15	Odile	H	23 Sep – 2 Oct	125	935		
16	Polo	H	28 Sep – 1 Oct	65	987		
17	Rachel	T	27 Sep – 3 Oct	55	994		
18	Simon	T	9 – 14 Oct	60	990		
19	Trudy	H	16 Oct – 1 Nov	135	924		
20	Vance	H	21 – 31 Oct	85	975		

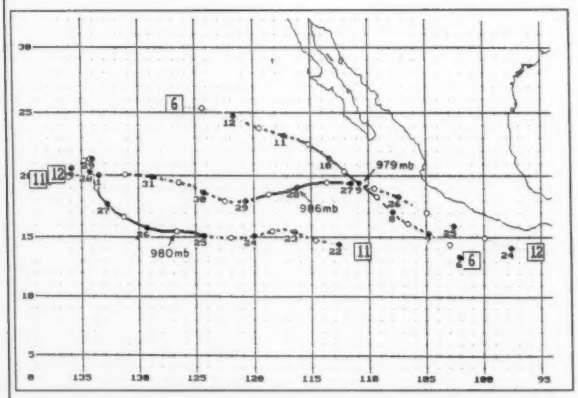
[1] T: tropical storm, wind speed 39–73 knots.
H: hurricane, wind speed 64 knots or higher.

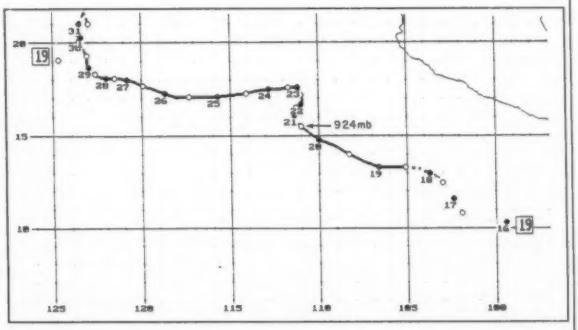
[2] Dates begin at 0000 UTC and include tropical depression stage.

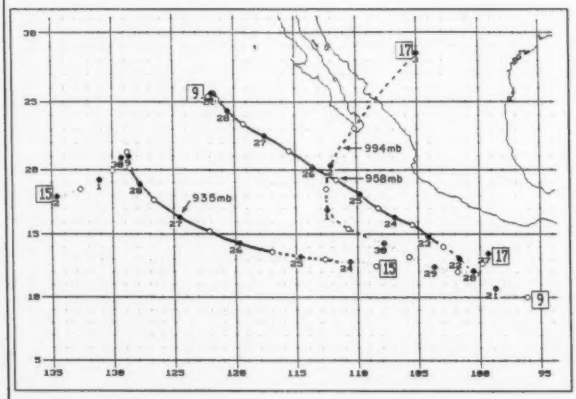
Eastern North Pacific Tropical Cyclone Track Charts—1990

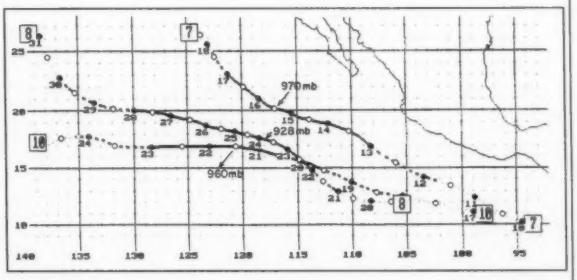


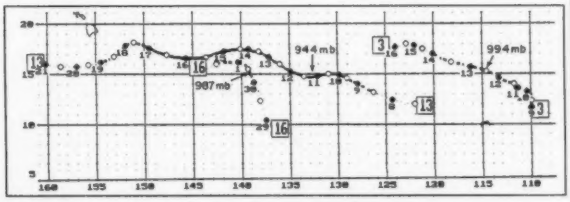












Legend

See previous page for Track Numbers

.....	Tropical depression stage
— — — —	Tropical storm stage
———	Hurricane stage
+++++++	Extratropical stage
▷▷▷▷▷	Subtropical depression stage
▶▶▶▶▶	Subtropical storm stage

H	HURRICANE
T	TROPICAL STORM
ST	SUBTROPICAL STORM
•07	Position and date at 0000 UTC
▫	Position at 1200 UTC
997mb	Lowest central pressure in millibars
6	Initial position of cyclone "Number 6"

What are Tidal Waves and Can They be Forecast?

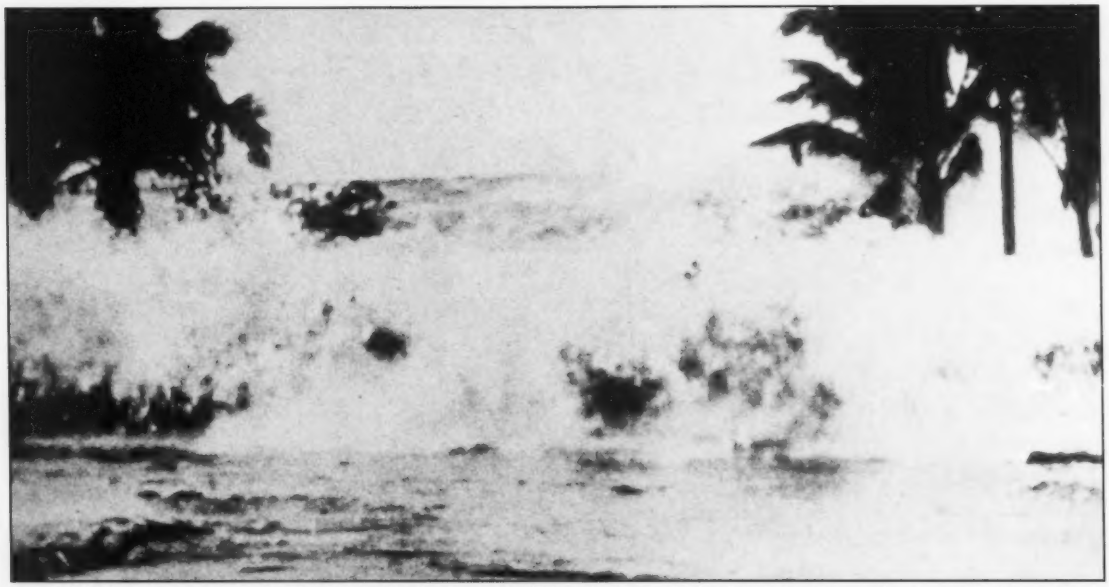
Lt. j.g. Jeff Brown, NOAA

The common tidal wave is not caused by tides. It is actually a Tsunami, (soo-NAH-mee; spelled identically for singular and plural), which is a Japanese word with an English equivalent of "great wave(s) in harbor." These waves are unlike the familiar wind waves that cause surf. Tsunami are very long period (15-120 minutes) waves caused by a sudden displacement of the sea water. They form and propagate much as the ripples created by tossing a pebble into a pool of water. Tsunami are created by earthquakes—causing vertical crust displacement in the ocean—submarine landslides, landslides into the ocean, and volcanic or nuclear blasts under or near the sea surface. Earthquakes are the most common method of generation, but all of the source mechanisms are associated with seismic waves. Today's knowledge of these seismic waves and the principles of wave propagation allows coastal communities to be prepared for tsunami.

Tsunami cannot be predicted and one has never been observed by sight in the deep open ocean, ironically, due to its size. The wind waves most of us are familiar with are of short wavelength, generally on the order of hundreds of feet. A tsunami, however, has a wavelength of hundreds of miles and, while the entire depth of water is in motion even in deepest areas of the ocean when a tsunami passes, its wave height is usually less than 1 meter (3 feet) in deep water. Since all ocean depths are shallow compared to the wavelength of a tsunami, the speed of the wave is proportional to the depth. This speed can be calculated and in the deep open ocean exceeds 500 knots. It is this speed and the fact that the amount of water in the crest of the wave is enormous due to the very long wavelength that gives the tsunami its destructive power. When the ocean becomes shallow, as it does on the continental shelf, the wave crest begins to build in height and the wave slows but may still travel at a speed of 50 knots. When this mass of water hits the beach the water may run-up and flood well above the usual surf, causing extensive damage to coastal development as well as causing rapid water level changes in the harbor area.

Those unfortunate enough to be at the shore when a tsunami is sighted may not have time to reach safety and could be carried out to sea with the backwash. This is how many people fall victim to tsunami: by being too close, too late. Also many people have been lured into their paths when the trough of the wave precedes the crest. When the trough arrives the water may drain from the coast sometimes out of sight, leaving fish and other sea creatures flopping high and dry. This tempts people to go out onto the seabed and collect these animals, only to be swallowed up moments later by the larger predator, the tsunami.

The water draining from the coast can actually act as a warning. If the sea recedes from the shore, one should immediately head for high ground, since the farther the sea recedes the greater the following crest will be. Remember, the crest can overrun the beach and flood much of the coastal lowlands rapidly and with such force as to severely damage even the most solid buildings.



April 1, 1946 was not, just another day in paradise for the people of Hawaii. Above, the April Fools Day Tsunami arrives at the Putumaile Tuberculosis Hospital on the Island of Hawaii. More than $26 million in property damage occurred that day in the Hawaiian Islands. This is an example of a large bore type wave.

A tsunami is not a threat to shipping on the deep open ocean. It is not a huge breaking wave in deep water. A ship on the high seas will not even notice its passing. The captain of a ship off of Hilo, Hawaii in 1946, noted no unusual seas but saw the waves crashing ashore. However, even a small tsunami can set up confused currents and seiches in the harbor. A study of Rabaul Harbor by Dr. Charles Mader of the Joint Institute for Marine and Atmospheric Research in Hawaii showed a single wave of ½ meter height could excite the basin causing 6–meter changes of water level to oscillate in the harbor. This oscillation can continue for days before completely dying out. For shipping the best defense against a tsunami is to leave port and get to deep water.

Fortunately, tsunami are less frequent than other natural hazards. However, they can happen at any time and in any body of water. They occur most frequently in the Pacific Ocean due to the number of earthquakes in the Pacific Rim. But they have occurred in the Atlantic Ocean, the Sea of Japan and the Mediterranean Sea. Intense storms, hurricanes and earthquakes can cause severe, but localized damage. Tsunami, however, can cause death and destruction over half of the earth in a matter of hours. This occurred during the April's Fool Day, 1946, Aleutian Islands tsunami and the Chilean, May 1960 tsunami. These tsunami caused death and damage in areas on the opposite side of the Pacific from where they were generated. Although large tsunami are rare, those living and working near the shoreline of a body of water should always be aware of this threat.

After the 1946 April Fools Day Tsunami, scientists of what is

Tsunami Watch— an event has occurred that might have created a tsunami and that the watch areas should prepare for the possibility of a tsunami.

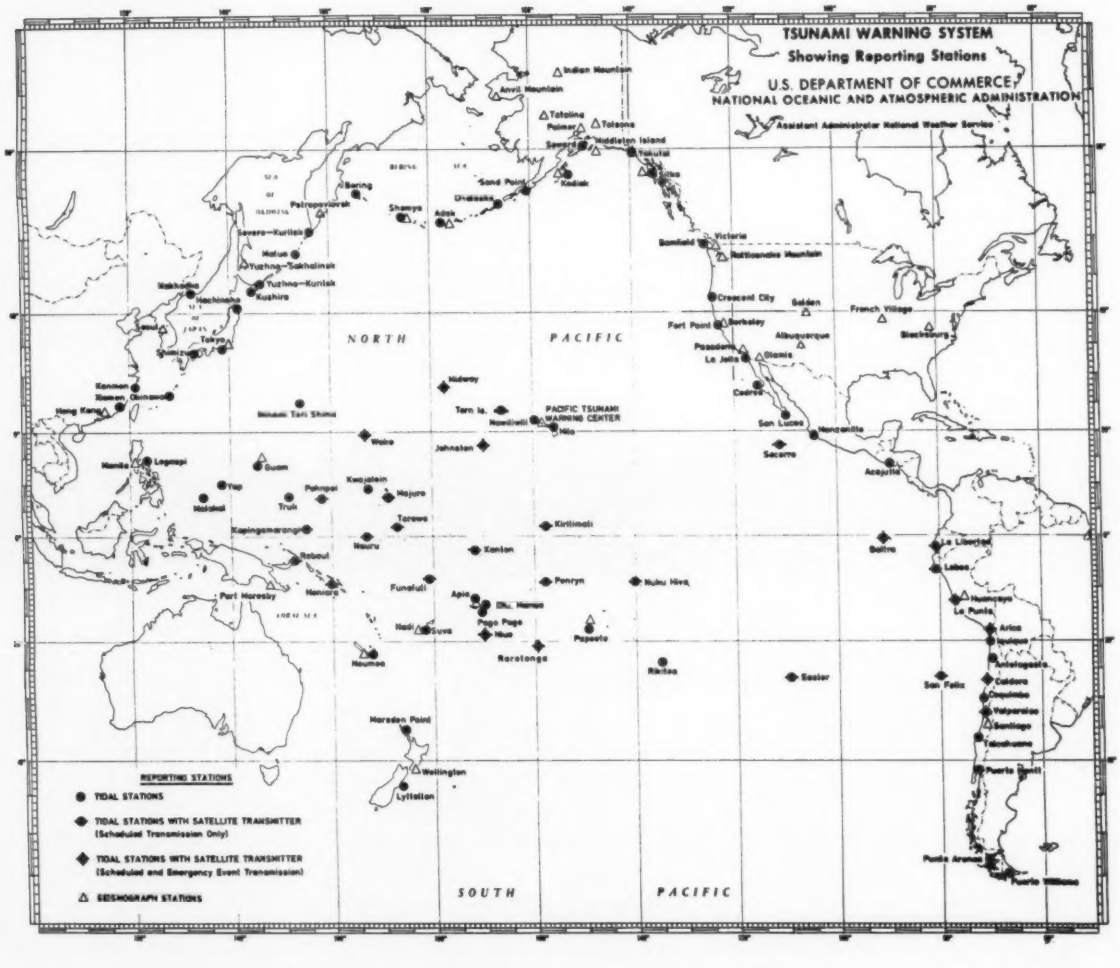
Tsunami Warning— a tsunami has been detected and will strike the warning area, or a possible tsunamigenic event has occurred and the warning area is so close to the generation area that the tsunami would strike the coast within 1 hour of its generation. This last area would most likely have felt the earthquake. In fact if those in a coastal area experience a strong earthquake, they should leave the coast, as a tsunami could arrive before a warning could be issued.

now called the National Oceanic and Atmospheric Administration (NOAA) devised a system to warn the coastal communities in the United States of an approaching tsunami. In 1952 a tsunami struck the Hawaiian Islands causing $800,000 in damage, but no lives were lost due to a prompt warning.

After the Chilean tsunami of 1960 caused Pacific-wide damage, the Intergovernmental Oceanographic Commission formed the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) and the International Tsunami Information Center (ITIC) in 1968. ITIC coordinates activities that promote the improvement of the International Tsunami Warning System (ITWS) and tsunami preparedness throughout the Pacific Basin. The ITWS has its operational headquarters at the Pacific Tsunami Warning Center (PTWC), Ewa Beach, Oahu, Hawaii. PTWC is operated by the National Weather Service, and serves as an international Pacific-wide tsunami warning center, working closely with regional and national warning centers to monitor seismological and tidal stations for indications of potentially tsunamigenic earthquakes. The regional and national centers are operated by member states of ICG/ITSU to provide rapid warnings to specific regions of the Pacific Basin. These centers have specific national responsibilities or, as in the case of the Alaska Tsunami Warning Center (ATWC), are situated in historically tsunamigenic regions and provide much

U.S. Coast Guard

The scene was Scotch Cap Lighthouse on Unimak Island, AK, April 1, 1946. The station was manned by five U.S. Coast Guardsmen. The midwatch had just come on duty when the earth began to shake at about 0130 (LST). This was followed by a second earthquake 27 minutes later. At 0218 the Scotch Cap Lighthouse ceased to exist (above). All that remained was a small section of the back wall and a concrete slab. The old lighthouse to the left was also destroyed. An antenna 105 feet above sea level had been washed away and debris was deposited 115 feet above the sea. Notice the scouring of the cliff face. Insert is Scotch Cap Lighthouse prior to April 1, 1946.



faster warnings for locally generated tsunami. In the United States, PTWC has this responsibility for the Hawaiian Islands, while (ATWC) serves Alaska and the Pacific coasts of Canada and the United States.

When an earthquake occurs anywhere on earth with a magnitude sufficient to activate the seismic alarms, its position is immediately triangulated. If the quake is in a coastal area in the Pacific Basin and is greater than the threshold for the creation of tsunami in that area, a tsunami warning/watch is issued for the immediate coastal areas. This bulletin is transmitted to all participating stations in the Pacific via military, aviation and commercial communication lines and satellite. A series of tidal stations operated by the tsunami warning center, national organizations, and various universities are located around the Pacific. The stations nearest the epicenter are watched for any sign of abnormal waves. The gauges are monitored by local observation or by satellite transmissions of the data with relay via worldwide meteorological circuits. If a tsunami is confirmed and is of a size to be a danger to coastal areas, the warning/watch areas will be expanded. If an identifiable wave fails to appear at the expected time, or the amplitude of the wave is small at several stations, the warning/watch area will be decreased or cancelled. The wave size is important as a tide gauge can measure a tsunami of only a few centimeters but this water rise would not be noticeable to sunbathers on the beaches.

Tsunami Tips

1. All earthquakes do not cause tsunami, but many do. When you hear that an earthquake has occurred, stand by for a tsunami emergency.
2. An earthquake in your area is a natural tsunami warning. Do not stay in low–lying coastal areas after a strong earthquake has been felt.
3. A tsunami is not a single wave, but a series of waves. Stay out of danger areas until an all–clear is issued by a competent authority.
4. Approaching tsunami are sometimes preceded by a noticeable rise or fall of coastal water. This is nature's tsunami warning and should be heeded.
5. A small tsunami at one point on the shore can be extremely large a few kilometers away. Don't let the modest size of one make you lose respect for all.
6. The Pacific Tsunami Warning Center does not issue false alarms. The tsunami of May 1960 killed 61 people in Hilo, HI, and they thought it was just another false alarm.
7. All tsunami —like hurricanes— are potentially dangerous, even though they may not damage every coastline they strike.
8. Never go down to the shore to watch for a tsunami. When you can see the wave you are too close to escape it.
9. Sooner or later, tsunami visit every coastline in the Pacific. Warnings apply to you if you live along any Pacific coastal area.
10. During a tsunami emergency, your local civil defense, police and other emergency organizations will be trying to save your life. Give them your fullest cooperation.

For Further Reading about Tsunami

United States Tsunamis (including United States Possessions) 1690–1988, J.F. Lander and P.A. Lockridge; Publication 41–2 DOC, NOAA, NESDIS, National Geophysical Data Center, August 1989.

Some Personal Experiences with Earthquakes, Rear Admiral L.G. Billings, U.S. Navy, Retired; *National Geographic*, Volume 27 No. 1, 1915.

Tsunami, Frank Forrester; *Weatherwise*, April 1987

Tsunami: Trouble for Mariners, Patricia Lockridge; *Sea Technology*, April 1989

Split Rock Lighthouse

Elinor DeWire

As the Great Lakes shipping season neared its close in 1905, carriers began tallying up their purses with excitement. More freight had been moved in and out of the lakes that year than ever before and, with several hundred vessels yet to complete their runs before the December 1 deadline, it promised to be a record season.

And record it was, but in a way no one expected. On November 23, just three days before shipping ended for the winter, a violent gale blew up, sending blinding snows and 60–mph winds ripping across the lakes. On Lake Superior alone, 29 ships were damaged or sunk. Three of these were stricken in a remote area of northern Minnesota known as Split Rock.

The powerful Lakes Carriers Association pressured Washington to build a lighthouse and a signal station at Split Rock. Among their arguments was the fact that magnetic characteristics in the rocks around Split Rock caused a compass deviation that put ships on a collision course with shore. Compounding the situation was the extreme depth of water so close to

National Archives

St. Paul Dispatch

shore— too close and too deep to allow soundings to verify position.

Congress assented. In March 1907, $75,000 was appropriated for the building of a lighthouse and fog signal at Stony Point, some fifty miles northeast of Duluth and only a few miles north of the tiny settlement of Two Harbors.

By the end of the construction season in 1909 (left), workers— earning $0.35 hour— had completed three keepers' houses and the fog signal building and had framed the octagonal skeleton of the 54–foot lighthouse. Above is a dramatic aerial view of Split Rock Light Station taken in June 1959.

The site was a sheer precipice rising 178 feet above Lake Superior. Like many of the rock formations in this region, it was dappled gray and topped by graceful, wind–driven evergreens. But it was the deep vertical fissure running down its face that made it so striking when viewed from the water.

Ironically, a surveyor mapping the coast in the 1850s had noted that Split Rock was "good for a lighthouse." No doubt he was anticipating the onslaught of capitalist interests that the 1855 opening of the Sault Ste. Marie Canal would bring. But he couldn't have envisioned anything quite so picturesque as the Victorian–style sentinel that first illuminated this spot in 1910.

Once funds had been approved for the building of Split Rock Lighthouse, the government began an earnest search for an engineer to do the job. The winning candidate was a young civil engineer named Ralph Russell Tinkham. His experience on the remote, vertical cliff at Split Rock would groom him for later, more challenging projects on distant islets in Alaska and Hawaii.

No roads connected Split Rock to civilization when construction of the lighthouse began in May 1909, and conquest of the cliff from water was complicated by foul

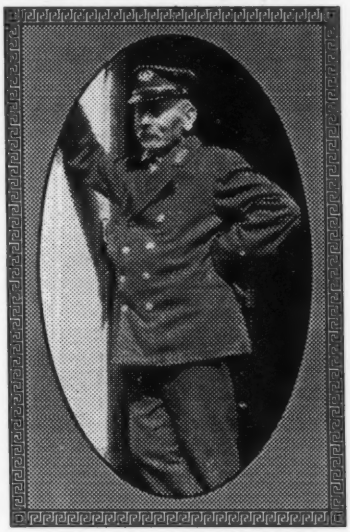
weather and the sheer rise of the cliff face. Tinkham first ordered a zigzag path out to the site from a nearby cove. A derrick and engine were then carried to the summit so building materials could be hoisted up the precipice from the scow–pulling tug, ***Red Wing***, out of Detroit. The entire station was completed in the summer of 1910 and put into operation without fanfare, for it was too isolated to attract many celebrants.

In the early years of its career, Split Rock Lighthouse was virtually inaccessible, except by water. Its three caretakers, a head keeper and two assistants, lived double lives. They and their families were brought to the lighthouse every April just before the opening of the shipping season. They kept the light burning and the foghorns blaring until mid–December when the station was shut down for the winter and the families returned to their permanent homes in the nearest towns. This practice of closing up the light for the winter continued until 1930 when families began living at the station year–round.

In summer, Split Rock was a pleasant, pastoral spot, set atop its speckled cliff backed by miles of untouched forest. Ileana Covell Meyers, who spent her girlhood years at Split Rock, remembers feeding the chipmunks she and the other children had tamed and "summer nights so idyllically quiet fish could be heard jumping far below in the dark water..."

But tranquil evenings were matched one–for–one with nightmares. Waves sometimes pounded the rock face so furiously it seemed as if all 170 miles of open lake had hurled itself at Split Rock. Wind could shred shirts on the clothesline or send pedestrians sprawling. Snow squalls came so thick that keepers were forced to tether themselves with ropes for fear of losing their way. And as Winter's deep freeze overtook the lighthouse, ice ground against the cliff with such force it seemed as if the ancient glaciers that carved the lakes had returned.

Isolation made life difficult too. The lighthouse tender ***Amaranth*** stopped by about every 3 months, bringing supplies, amenities, and guests— if they were prepared to stay awhile. Keepers willingly made the 12–mile trip by rowboat to Beaver Bay once a week to get mail and extra supplies, or to fetch a doctor when needed, but always at the mercy of the weather. Split Rock families accepted the possibility that they might be marooned in the wilderness for weeks, with no one able to get in or out.



National Archives

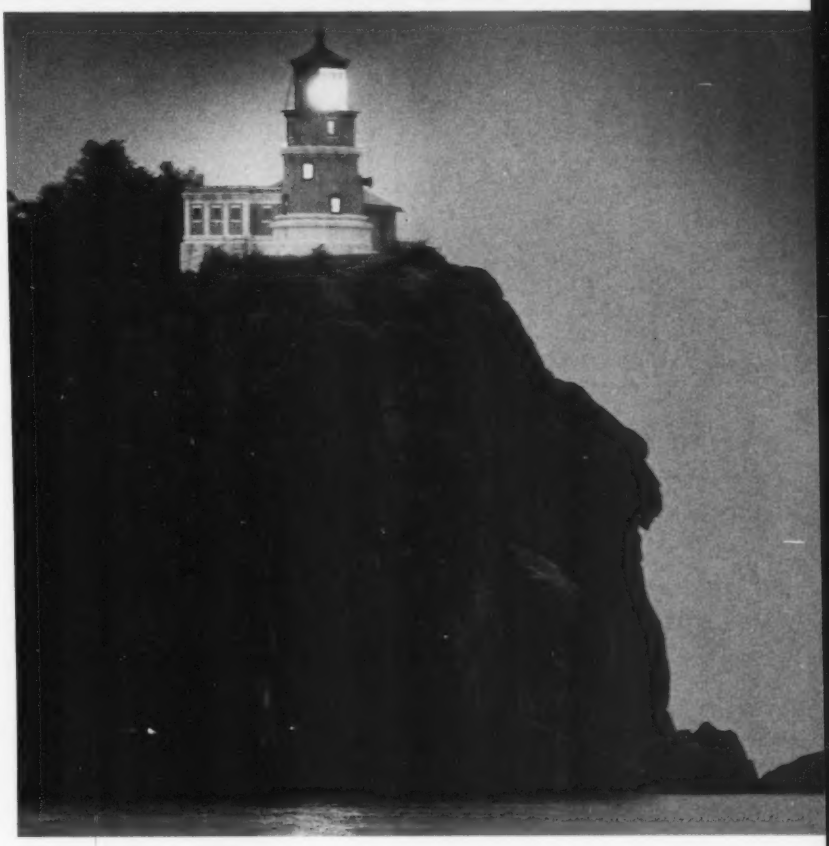
Contact with the outside world burgeoned in 1924 when the North Shore Highway was built and a dirt road was cut from the high-

Minnesota Historical Society

A tramway was built in 1916 to deliver supplies to the top of the 130–foot cliff from lighthouse tenders on the lake (left). Photograph is circa 1920 and provided through the courtesy of the Minnesota Historical Society. This method was used until 1934. Orren "Pete" Young (above) served as head lightkeeper from 1910 until 1928. The photo was taken July 5, 1926. Although decommissioned in 1969, Split Rock Light is still lit by the Minnesota Historical Society for special events. This photograph, on page 39, was provided by the courtesy of the Duluth News–Tribune.

way to the light station. Isolation ended and visitors poured in by the thousands, drawn to Split Rock's majestic, lakeshore setting and the curiosity of the lighthouse and its keepers. Orren Young and his assistant, Frank Covell, began wearing two hats— lightkeeper and tour guide. At first, tourists came only on Sundays, but soon they were arriving by the busloads every day of the week during warmer months. In 1937, for example, Covell estimated that as many as 60,000 visitors came to the lighthouse.

These large numbers necessitated establishment of visiting hours and rules of conduct while on the lighthouse grounds. Guests were permitted in the lantern room until scratches began to appear on the valuable Fresnel lens. They were allowed to climb out on the lofty lantern deck until several people were knocked down by the wind. Split Rock became known as "the showplace of the district." Fences and signs were put up to steer tourists away from trouble and ensure privacy for the families. In 1938, at the strong recommendation of Keeper Covell, a safety fence was placed at the base of the tower where the cliff dropped 178 feet down to the lake.



Bob King

Split Rock Lighthouse became obsolete as a navigational aid in 1969, but its popularity as a tourist spot encouraged the state of Minnesota to open it to the public in 1971. Its current resident caretaker, Lee Radzak and his family feel a kinship with the old keepers who long ago tended Split Rock's magnificent beacon. Though they operate a gift shop, show a movie about the light's history, and oversee the site's many trails and campground, there are still days when the reality of living at a Great Lakes lighthouse becomes clear.

Radzak admits he and his family have been "captivated by the same sunrises and moonrises over Lake Superior that the keepers saw during their long nights on duty." He's also had to endure power outages, waves throwing spray over the cliff, and blizzards that bring everything to a halt. In Radzak's words, the place never shows "the same face two days in a row."

Every year on November 10, the Radzaks light the beacon as a tribute to the ore carrier ***Edmund Fitzgerald***, which went down with all hands in a November 10, 1975 storm. In doing so, they retrace the steps of Split Rock's early keeper and remain mindful of Lake Superior's split personality—an inland ocean that is both serene and terrible, even for modern mariners and lightkeepers. On this commemorative night, the original 4.5–ton lens turns on a mercury float, powered by clockworks and 250–pound weights which must be wound up manually—just as they were in 1910.

Split Rock historic site is open daily 9 am – 5 pm May 15 through October 15. In winter, visit the site on weekends from noon to 4 pm... weather permitting.

The next issue of the Mariners Weather Log will feature an article on the November storms of Lake Superior by Thom Holden —ed.

Some Thoughts on Photography

Michael Halminski

For me making a livelihood from photography has been an ongoing experience. This learning process is particularly important since I lack much formal training in the field. Like many people, I've learned from experience and mistakes. The basics of camera operation can be learned from reading the manual that comes with the camera. A lot of people overlook this seemingly basic step in their anxiety to get started, but it is always good to go back every once in awhile and take another, or in some cases a first, look at it. Individual creativity can come into play with the use of various shutter speeds, f stops, composition, and even film choices. These are topics I hope to touch on in future columns.

Probably the most basic aspect of photography to me, is having the camera at hand when the opportunity arises. My work is usually spontaneous, and I frequently have to react to situations that happen suddenly, especially where weather and natural lighting are factors. This seems most evident in a marine environment.

Mariners have the unique opportunity to record this environmental drama on film. Things that you take for granted may be interesting or have a great visual impact on others. My philosophy is that if something catches my eye, I shoot it. Film is the least costly material in photography, and I won't hesitate to use it up when a situation presents itself.

Sometimes the results are not what I saw or expected, but often I am pleasantly rewarded with a striking image. Either way it's not a particularly expensive effort. The photograph on the next page, I shot several years ago, while working as a crew member on the Chesapeake Bay skipjack, ***Virginia W.*** My intent was to obtain a photographic record, while culling oysters, of a vanishing industry that still used sail power. As a result, I was able to capture many memorable if not historic moments. So keep that camera ready and do some shooting.

I would like to add that Mike has indicated that he is willing and, in fact, encourages questions from readers. So if anyone is having problems with their photographs or has a question regarding filters, film, technique or the like, please write to either the Log or directly to Mike at:

Michael Halminski
Waves, NC 27982
USA

—ed

New Zealand Pacific Rescue Effort

Captain David Watt

*(The story of the rescue of the two crewmen from the **Great American** is told in the following edited routine report filed by David Watt, Master of the New Zealand Pacific.)*

At 1500 (all times LST) on the 22d of November, I answered a Catcall from the U.S. Coast Guard New York (AMVER) informing me that they had received details of a distress call from an Argos beacon of the ***Great American*** about 400 miles west of Cape Horn and enquired as to whether or not I was in a position to offer any assistance. At that time we were about 100 miles away and I informed the Coast Guard that I would proceed at best speed possible under the present weather conditions to give any assistance possible. At the time we were encountering Force 12 winds (64 knots or more) and very heavy swell. Due to these conditions we had to dogleg slightly. Coast Guard New York then handed over control of the effort to MRCC Valparaiso as coordinator. However, as things developed later with language difficulties on Radio Telephone with shore operators, both of us found it more convenient to continue using New York as a go–between. Satcom telephone was handy for this purpose. I reached the distress position at 2230, after darkness had fallen (lots of SATNAV fixes in that part of the world made this easy). Toward the latter part of the journey we were calling on CH 16 VHF and sounding the ship's whistle at frequent intervals.

Earlier in the evening I had discussed with the other Officers our various weather options, and come quickly to the conclusion in present weather we had none, other than the leeside pilot door. We readied everything to assist with the recovery or otherwise.

With no answer to either VHF or whistle, and in darkness, after about 30 minutes I decided that in the present weather we would have very little chance of spotting anything before daylight, which was only about 3 hours away in that part of the world. We began to pull away when the yacht was observed passing down the ships starboard side. However, due to my headway, I had to take two full 180° turns with a run in between to again bring my starboard side door to the lee side. During this time we lost sight of the yacht, but were aware of the EPIRB strobe light flashing dimly in the darkness, and we again picked up the yacht. It was 2355 when we eventually started to maneuver down toward the craft.

Initially it appeared the craft was deserted, but a blast on the whistle brought some action and two people were observed waving from the deck. I maneuvered the ship into a position upwind and beam on to the sea and wind and allowed it to drift down as gently as possible using engines and thruster and actually succeeded in landing alongside with the yacht directly underneath the pilot ladder door. Fortunately both men were uninjured and were able to clamber up the pilot ladder unaided and we had them aboard by 0032 on the 23d. By this time weather conditions had eased somewhat, with the wind out of the west southwest at Force 8 (34 to 40 knots) with rough seas and moderately heavy swells.

The yacht was left drifting with, unfortunately, both beacons still operating, but this was reported along with the details of the rescue to Coast Guard New York and MRCC Valparaiso. The vessel then resumed its passage to Flushing. I would be remiss to finish this report without mentioning the excellent work put into this whole rescue operation by virtually all on board, who seemed to manage to contribute something in one way or

another and have since succeeded in supplying our survivors with a motley collection of clothing and footwear. To the Chief Officer, Bosun and 2 AB's, who got very wet in the pilot door, go my particular thanks.

PMO New Zealand

Julie Fletcher, Port Meteorological Officer for New Zealand, visited the *New Zealand Pacific* on the 31st of January 1991. She was kind enough to send us copies of their meteorological logbook for the period and also included the barogram from November 19 to 25, 1990. Julie notes that a comparison of the barograph trace with the observations shows that the barograph lagged behind as the pressure rose, following the lowest recorded pressure at 0000 UTC on the 22d. After the 25th the barograph developed a fault and the trace was as much as 10 mb in error, so she replaced the faulty barograph. Julie also mentions that the officers on board the *New Zealand Pacific* provide regular and reliable weather observations.

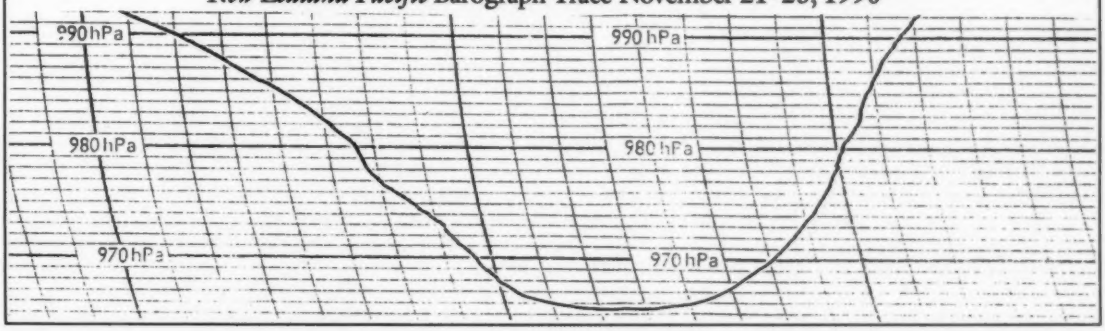
I.B. Owen, Marine Operations Manager for the New Zealand Line, provided us with Captain Watt's report and informed us that the *New Zealand Pacific* was built at Bremer Vulkan, Germany in 1978 is 248.58 meters in length and its gross tonnage is 42,276 with a service speed of 21.5 knots. The vessel is managed by Cunard Ellerman of London for whom New Zealand Lines acts as agents, and the crew are all New Zealanders. The vessel is part of the ACT (A) London fleet in a round the world service to and from Europe to Australia and New Zealand eastbound via the Cape of Good Hope and Cape Horn. Over the years the vessel has been the recipient of several AMVER awards, the last one presented in Wellington by the American Embassy.

Dutch Storm Revisited

In the Casualty section of the Marine Weather Review for February of 1990 (Summer 1990 issue), we reported that the *Anneliese* was abandoned by its crew after its bridge collapsed in heavy weather in the Dutch Sea sector of the North Sea.

Jan Nieuwenhuis of the Electronics Department of the Netherlands Institute for Sea Research (NIOZ) was kind enough to send to Jim Nelson, PMO of Houston, several photographs that he had taken of the *Anneliese* (page 44) a few days after the coaster stranded in the Netherlands. The vessel was on its way from Wismar, Germany to Banff in Scotland when it ran into the storm. The crew of six were lifted off by helicopter.

New Zealand Pacific Barograph Trace November 21–23, 1990



New Zealand Pacific Weather Observations November 22–23, 1990 (condensed version)

DATE	POSITION LAT. deg.	POSITION LONG. deg.	TIME GMT	WIND DIR. 10 deg.	WIND SPEED kn.	VSBY code	PRES WX. code	PRESSURE mb.	TEMP °C Air	TEMP °C Sea	SEA WAVES PD. sec	SEA WAVES HGT. ft.	SWELL WAVES DIR	SWELL WAVES PD. sec	SWELL WAVES HGT. ft.
22	55.8	92.1	0300	30	60	93	19	964.6	5.5		10	16	30	15	32
22	56.3	88.7	0600	27	60	93	27	965.1	4.5		13	20	27	15	45
22	56.6	85.4	1200	25	60	93	63	969.3	3.2		10	16	27	18	45
22	56.9	82.3	1800	25	60	93	44	977.1	3.5		9	16	25	15	45
23	56.3	79.5	0000	24	37	97	22	988.9	2.5	4.8	7	12	24	15	32
23	55.5	76.2	1200	25	30	98	27	1004.0	3.4	5.0	6	10	22	10	23
23	55.8	72.9	1800	24	24	98	02	1006.7	6.0	5.0	6	8	24	10	16

Note: In the visibility code 93 represents more than 500 meters but less than 1000 meters.
Pressure in mb and hPa are interchangeable

SARSAT

On March 4, 1991 the fishing vessel, ***Mr. Prowler***, off the coast of Venezuela, was battling 12–foot seas and the boat was taking on water fast. The seven men on board were not only in danger of losing their ship, but they had the real possibility of not returning to port at all. Luckily, they had a radio beacon and NOAA was listening. "The case of Mr. Prowler is a good example of how SARSAT works and what it can do in the best of circumstances," said Robert Brezler, NOAA's chief SARSAT controller. "If all the right conditions are met," he continued, "we can do amazing things."

A NOAA GOES satellite first picked up a signal from the ***Mr. Prowler's*** 406 MHz radio beacon early on March 4. The advanced 406 MHz beacon can give rescuers more information than the standard beacon, such as a unique ID. And if the beacon ID is registered with SARSAT, then a whole host of data is available. The beacon was detected a second time by a low earth orbiting satellite about 1 hour later. In that time, aircraft based in San Juan, PR, sped toward the stricken ship and made several attempts to drop water pumps to the vessel, to no avail. A helicopter was called in and successfully delivered one of the pumps. The vessel was eventually towed in along with its crew of seven. From January 1 through the middle of March of this year SARSAT was credited with saving 28 people in seven incidents on sea and land in such diverse locations as Florida, Hawaii and Alaska.

Metric and Beyond

In a major policy shift the Mariners Weather Log, which claims to be an international magazine, has conceded that there is a metric system out there and that, all and all, it is pretty good.

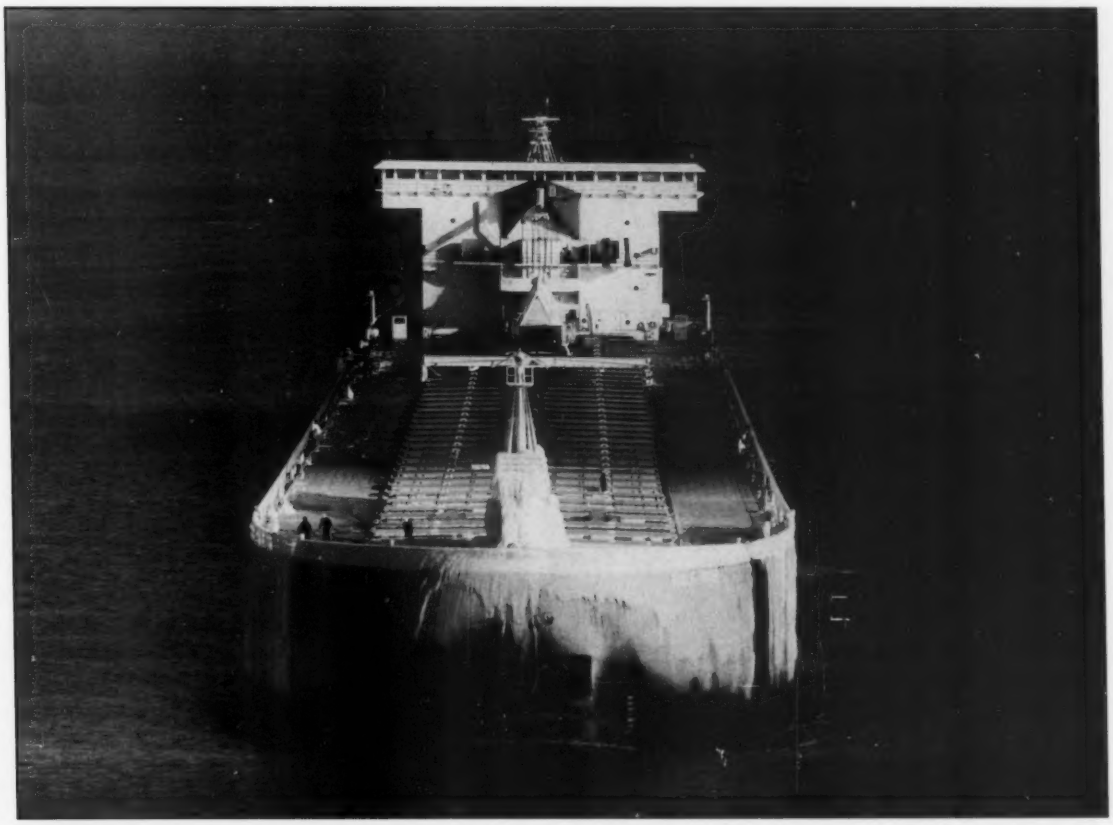
We will begin, in this issue, a long period of conversion, starting with the Marine Weather Review section, where we will carry dual measurements. Eventually the publication will become metric entirely. This will take a little time. After all it took awhile to prove that the earth wasn't flat, a fact we acknowledged many issues ago. We plan to use °Centigrade, meters, nautical miles, kilometers per hour, millimeters and hectopascals (in place of millibars). Any objections?

New Staff Member

A welcome addition to the informal staff of the Mariners Weather Log is Jerome Robert Bielicki, a self–employed photographer from Duluth, MN. Jerry produces visual material for communication, educational and promotional purposes. He also photographs news events, locations, people and other illustrative subjects for use in publications or telecasts, using still or video cameras.

Jerry has numerous credits in various fields of photography, and his outdoor work is great. He has written and taken photographs for *Seaway Review, Work Boat, Lake Superior Magazine* and *Weatherwise.* He has won awards from Eastman Kodak, the U.S. Naval Institute and Minnesota Cable TV. Included in these is an award for meteorologic photography. His educational background includes Industrial Graphics at Macomb County Community College, Marketing/Radio, Television and Film at Wayne State University and Photojournalism at Northern Michigan University—NCAA Collegiate Hockey Champions for 1991.

Jerry has worked as a Public Information Specialist, Media Specialist and in television production. In his own business he has contracts with a wide variety of customers, including the Army Corps of Engineers, Port Authority Duluth, Interlake Steamship Co., Bethlehem Steel, American Steamship Co. and the U.S. Naval Institute. We are pleased that he has become a part of the Mariners Weather Log, to help us expand our coverage of the Great Lakes. While we could go on and on about his credentials and talent, it's much clearer to let his pictures do the talking (for example, below).



Cold November Duluth Arrival for the 1000–foot ***Wm. J. McCarthy Jr.***

Getting to Know Your PMO

Lawrence Cain, PMO Jacksonville

MWL: Larry, how did you get started in weather?

Larry: I enlisted in the U.S. Navy in 1961. I then got the chance to attend the Weather Observer, Radiosonde and Air–Ocean Environment Schools at Lakehurst Naval Air Station in New Jersey.

MWL: What type of work did you do in the Navy?

Larry: I worked as an observer for 7 years and in 1968 returned to Lakehurst to attend forecaster school. I served on most types of Navy ships, including destroyers, aircraft carriers and amphibious warfare vessels.

MWL: When did you join NWS?

Larry: My first job in the National Weather Service was as a Weather Radar Specialist at Galveston, Texas in 1981. I transferred to Jacksonville as PMO in 1987.

MWL: Jacksonville is a large city isn't it?

Larry: It is the largest city area–wise in the 48 contiguous United States and is the second largest port in Florida in terms of total tonnage handled, right behind Tampa.

MWL: Is the port as spread out as the city?

Larry: The port is spread out along the St. Johns River from the Inter–Coastal Waterway south to Green Cove Springs, FL. This includes three shipyards, two major marine terminals run by the Jacksonville Port Authority and numerous privately owned shipping terminals.

MWL: What kind of driving does this entail?

Larry: I drive approximately 125 to 150 miles a day. My area of responsibility also includes the ports of Savannah and Brunswick, Georgia and Fernindina Beach and Port Canaveral, Florida.

MWL: What type of shipping and vessels do you see?

Larry: The Port of Jacksonville is a major hub for South Atlantic shipping. However, traffic to and from Europe, the Middle East and along the coast is not uncommon. We see all types of vessels at the port, including Autoliners, Ro/Ro [Roll on Roll off], Container and Petro/Chemical Carriers.

MWL: Are there seasonal variations in the ship traffic?

Larry: Shipping is pretty steady year round, with some slight increase during the summer months

MWL: Where do you live?

Larry: I live in Orange Park, Florida with my 13–year old daughter, Colleen.

MWL: How about hobbies?

Larry: My two hobbies are golf and coin collecting.

Novak's Odyssey

Bob Novak, PMO San Francisco, took an interesting familiarization trip aboard the training ship ***Golden Bear*** of the University of California Maritime Academy at Vallejo, California. The Master was Captain John Keever with a crew of 49 and 239 cadets. They left California on the 16th of January and headed for Montivideo, Uruguay. Thanks to Steve Cook, the ship was equipped with a SEAS unit and there was also a facsimile machine aboard.

Bob was assigned a senior cadet each day and taught them how to take and transmit two synoptic weather reports, tune and copy a facsimile chart, and produce a short forecast. He was also a guest speaker for four classes covering weather and synoptic observations.

The 495–foot ***Golden Bear*** was built in 1939–40 by Bethlehem Shipbuilding Company. After serving as a commercial vessel named the ***Del Orleans***, the Navy took her over in June 1941 and converted her into a troop transport. She was commissioned the ***Crescent City AP40***. On the day after Pearl Harbor, she sailed for Norfolk for her first load of troops. For the next 3 years she participated in the landings on Guadalcanal, Guam, Leyte and Bougainville as well as operations at Okinawa, Malaita and the Southern Palaus.

After the war, she continued to ferry troops until 1950. She was moth–balled with the reserve fleet at Norfolk until 1960 and at Vallejo until 1970. Then in 1970 the tons of guano were hosed off, the ship was cleaned up, and was given to the California Maritime Academy.

Throughout the trip the weather was exceptional. Skies were generally fair with winds in the force 2 to 3 range. The few weather systems that were encountered were mild, force 5 maximum. In some ways this was unfortunate, for teaching purposes especially.

In the upper photo, Captain John Keever (center), Master of the Golden Bear, visits with Chilean Pilots Captain F. Vargara (left) and Captain H. Nunez, while in transit of Chile's inland waterway leading to the Strait of Magellan. At left, Captain Ed Manden (left), Superintendent, Marine Operations, American President Lines, receives a plaque from NOS–SEAS Operations Manager Steve Cook (the older gentleman) in thanks for several years of participation in the IGOSS program.

Ray Brown hits 10,000

Ray Brown, PMO Norfolk is fast becoming an old timer in the VOS program. Recently Ray visited his ten thousandth ship, when he went aboard the USNS Relentless. Ray has been the PMO at Norfolk since 1980.

New PMO In New Orleans

Royce Hildebrand (above) has been selected to fill the Port Meteorological Officer position in New Orleans, replacing Jim Downing who retired last November. Royce has nearly 25 years of experience as a specialist in weather observations. With the U. S. Air Force from 1967 to 1987, he was a weather observer specialist, weather observer instructor, forecast section chief, and solar data analyst/storms forecaster. His stations included Chanute AFB, Illinois, Louisiana, Taiwan, Florida, Puerto Rico, and Boulder, Colorado. After retirement from the military in 1987, Royce came to work for the National Weather Service at Stephensville, Texas, where he was a radar, surface, and upper air observations specialist. He lists his hobbies as golf, golf, golf, and sometimes golf. Married, with one daughter and a grandson, Royce is currently completing course-work for a Bachelors degree.

Word from the Gulf

We received a letter from LCDR Philip G. Renaud, U.S. Navy Oceanographer stationed in the Arabian Gulf. Here is an excerpt that we would like to share:

We're still out in the Arabian Gulf and the biggest weather event to date has been a classic shamal during 5–8 March. As soon as the northwesterlies set in we were enveloped in thick haze, which ended all flight operations on 7 March. Although the strong winds persisted through 8 March, the haze cleared as quickly as it had set in. It's fascinating to observe the smoke drift patterns from the Kuwait oil fires on NOAA AVHRR and DSMP imagery. We are the first ship to have the AN/SMQ–11 Satellite Receiver interfaced with the prototype Tactical Environmental Support System (TESS 3). It's quite a powerful onboard meteorological satellite processing capability and served well in support of "Desert Storm." We always enjoy the Mariners Weather Log!

A Connors Special

Pete Connors, PMO in Miami arranged a tour for some members of the Miami Meteorological Society aboard the NOAA Ship Malcolm Baldrige recently. ENS. Heather Packer (above) conducted the tour. Also shown in the photograph are, left to right, Victor Wiggert, Colin McAdie, Ed Rappaport, Roger Edwards and Dietrich Brassert.

Great Lakes Marine Weather Newsletter

The Great Lakes Marine Weather Newsletter is a semi–annual publication prepared by the Great Lakes Marine Weather Enhancement Program. It is designed to keep the marine community abreast of developments and changes in the program. If you want to receive this newsletter or want to see a particular topic addressed please write:

National Weather Service
Cleveland Hopkins Intl. Airport
Federal Facilities Building
Cleveland, OH 44135.

St. Paul Storm

David G. Vonderheide
NOAA

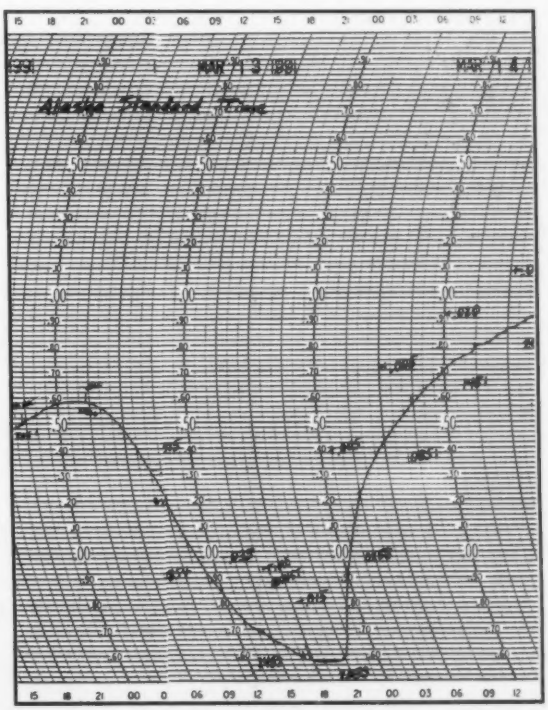
A strong storm center passed close to the weather station on St. Paul Island in mid-March. Submitted is a copy of a barogram record which you may find useful for publishing in the Marine Weather Review section. The phenomenal pressure rise that was sustained for many hours following the storm is obvious. Wind gusts went as high as 52 knots at the WSO, and the ***Arctic Storm***, southwest of St. George Island, reported winds of 75 to 80 knots.

The storm formed as a frontal wave in the northwestern Pacific Ocean, and began occluding before it reached the western Aleutian Islands. An older, larger low pressure area east of Kamchatka was acting to "steer" the occlusion into the Bering Sea. A fresh push of Arctic air greeted the arriving storm and gave it new vigor. Central pressure dropped to at least 961 mb around 1800 Alaskan Standard Time (AST).

An unusual aspect of this storm was a central region of scattered cloud, accompanied by a lull (wind under 25 knots), which lasted nearly 3 hours. Apparently an "eye" of sorts had passed over the Island, with southwest winds indicating that the true center was just north of St. Paul. At the same time a public safety official on St. George Island (40 miles south) estimated gusts in the 50–to 60–mph range, and mentioned that some wind damage had occurred to structures there.

Winds prior to storm passage were southeast gusting to 49 knots. During the lull, islanders and mariners alike had the impression that the "southeasterly" storm had let up. However, forecasters at the WSFO in Anchorage advised that a high wind warning would be needed, based on ship reports to the west, including that from the ***Arctic Storm***. The Arctic front whipped around the storm center and passed through the Pribilof Islands at about 2100 AST, bringing a sharp wind shift into the northwest.

Along with quickly increasing wind, the temperature dropped steadily and snow fell horizontally. VHF radio channels were busy with helmsmen describing the weather trouble. Vessels rounding the eastern end of the Island to get repositioned met a heavy southeast swell as well as the strong westerly wind. Some couldn't make better than 3 or 4 knots. One explained that he thought his barometer had broken. Another said his barometer was going up "like an elevator." By midnight the three-hourly pressure rise was 11.5 mb!



Currents Needed

Jennifer Clark
NOAA

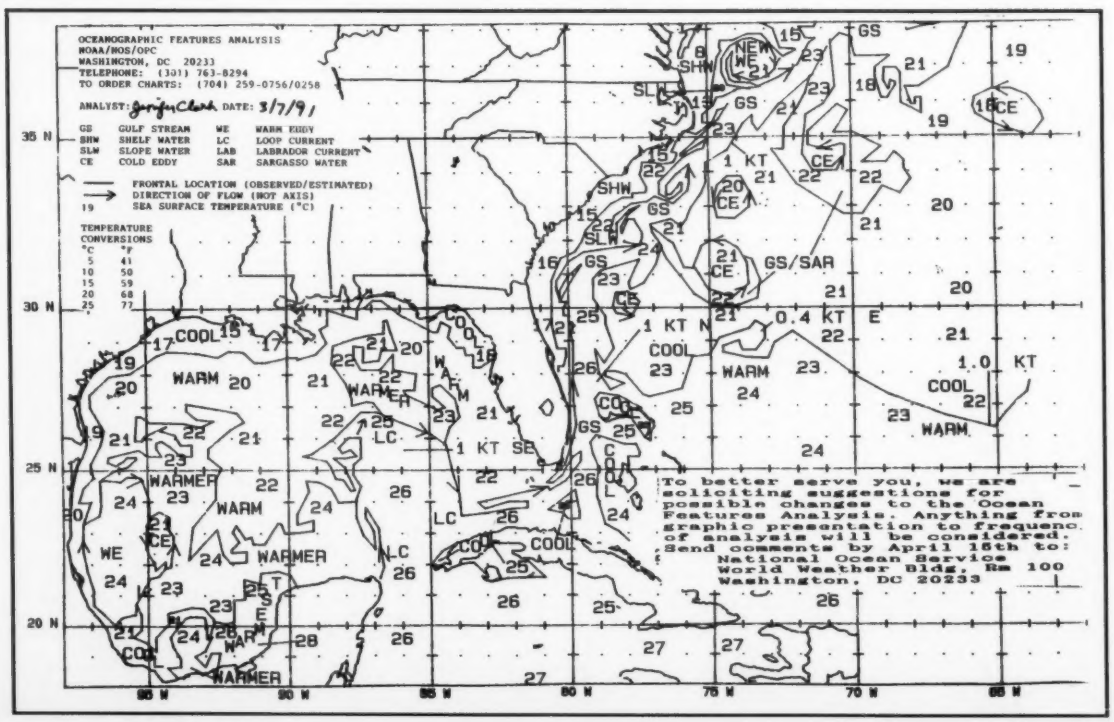
Dear Mariner,

The NOAA/NOS Ocean Products Center (OPC) sincerely appreciates your cooperative ship bathythermograph messages. This effort greatly contributes to the quality and quantity of XBT data and is helping the OPC build a climatology of water temperatures. The OPC is responsible for generating an Ocean Features Analysis (OFA) for the U.S. East Coast each weekday. The chart (below) is a sample of the South Panel OFA. The OFAs depict the location of the Gulf Stream, warm eddies, cold eddies and the Loop Current in the Gulf of Mexico. These features are determined by analyses of thermal infrared satellite images. We cannot determine current speeds and directions from the satellite images. It would be very useful to plot current velocities observed by ships of opportunity on the OFA. On the XBT messages, there is a 66666 optional group designator for surface current speeds and directions. The OPC encourages ships to routinely list current velocities (by set and drift, GEK, etc.) Since the OPC is considering expanding OFAs to other oceanic areas, we also need surface current velocities in areas other than the western Atlantic Ocean.

A final note, there may be some confusion regarding the convention for current direction, which is different from the convention for wind direction. Currents are reported toward the direction in which they are flowing, while winds are reported from which direction they are blowing. For example, a westerly wind is blowing from the west (270°), while a westerly current is flowing toward the west (090°). When recording current direction, the ships of opportunity should be careful to preserve this convention or the current directions may be coded 180° off.

If there are any questions or comments, please write:

Jennifer Clark
National Ocean Service/OPC
World Weather Building, Room 100
5200 Auth Road
Camp Springs, MD 20746



Baron to Palmer

Martin S. Baron
National Weather Service

Mariners Weather Log editor, Dick DeAngelis, handed me a letter from Mr. George Palmer, a second mate living in British Columbia. It reads, in part:

Please resolve a heated discussion we had a short time ago. The vessel I was recently aboard participated in your weather reporting system. It was very economically equipped— no radio officer, no anemometer. The barometer was not calibrated very often, the barograph not calibrated at all (although we did get it to approximate the aneroid).

We accumulated many barograph sheets (some well annotated, most not at all), the big work sheets (WS Form B-81), and other related flotsam. The Captain insisted we bundle all this up and mail it to you.

Exactly what do you want us to send in, recognizing that 99% of what we accumulate duplicates the transmitted radio messages.

We also discussed nighttime observations of wind, seas, clouds, etc. During the day we get along fine with the Beaufort System, but having no anemometer is a handicap at night. Observations of wind, sea, and swell also become a poor guess at night, even with the help of spotlights. Would you rather have a poor/best guess of these elements, or should we leave these fields blank? My belief is that bad data is worse than no data, so we should leave the data out.

I'm sure there are many others with the same questions, so please answer in the Mariners Weather Log.

What to Mail-In

All of your observations, whether they've been transmitted or not, should be mailed to your PMO when you reach port, using the postage paid 12x16 inch envelopes. Transmitted and mailed-in reports are used differently. Transmitted reports are used by meteorologists as basic data for weather analysis and forecasting in real time. Mailed-in reports have two uses:

(1) in the compilation of climatological and historical records at the National Climatic Data Center (NCDC), in Asheville, North Carolina, and

(2) by the PMO to evaluate your observations.

When the PMO receives your reports, he looks them over for any obvious mistakes or code errors. Any problems he finds should be discussed with you the next time he comes aboard your vessel, or by mail, if necessary. The PMO then sends the reports to the NCDC, where they are catalogued on microfilm and saved indefinitely. This makes them available to a wide variety of users— scientists, ocean routing firms, attorneys, ocean and coastal engineers, ship builders, accident investigators, etc.

The standing NWS policy is that only completed observation forms (WS Form B-81) need be mailed in. Unless your PMO has indicated otherwise, Barograms and Weather Report For Immediate Transmission Forms (WS Form B-80), should not be mailed in. You can do with these as you wish. The Mariners Weather Log is always looking for good barograph traces.

Nighttime Reporting

There are a number of things you can do to improve your nighttime observations. Towards dusk, closely watch weather, sea and sky conditions for guidance about conditions likely to be present after daylight is gone. If weather conditions are stable, you can use the principle of continuity for assistance. If conditions are changing, note their rate of change.

If, during the hours of darkness, there is an onset of precipitation, bear in mind that the kind of precipitation can indicate the cloud type, as shown in the table. Use the appearance of stars when estimating total cloud

amount— many stars are visible in areas free from cloud, or under a clear sky, but only the brightest stars can be seen through cirrus, cirrocumulus, or cirrostratus. When the intensity of darkness is very great, the sky is likely to be covered with a dense low cloud, such as stratus. If there is any light at all, there may be patches of low cloud with some middle or high cloud above.

When determining visibility at night, allow at least 2 minutes for the eyes to adapt to night vision. The appearance of navigation lights at known distances gives a useful indication— the luminous intensity of the light will be greatest when visibility is very good. Silhouettes of objects on land, or of other vessels, can also provide an indication of the visibility.

On a dark night when the surface of the sea is invisible, wind speed can be estimated by noting effects on sound, on shipboard objects such as flags, and on smoke. A strong searchlight or beam of light may illuminate the sea surface enough to obtain information about the wind driven sea. Swells can often be identified and described by the roll and pitch of the ship.

When observing at night, make your instrumental observations requiring the use of light (atmospheric pressure, pressure tendency characteristic and amount of change, air, dew point, sea surface temperatures, and wind, if you have an anemometer) after the non-instrumental ones, so as not to impair eye function.

Data which you regard as inaccurate (whether observed at night or during the day) should not be transmitted. Use slashes for missing or bad data, but leave out (omit from the message) rather than slash out entire groups of missing data. This doesn't apply to any of the first 7 groups of the weather message (BBXX D....D YYGGiw 99LaLaLa QcLoLoLoLo iRixhVV Nddff), which must always be included in transmitted reports. Besides ship's position and report identification information, these mandatory groups contain cloud base height, visibility, fraction of sky covered by cloud, wind direction, and speed. Always try to estimate these elements to the best of your ability, using slashes if they are not available.

Mr. Palmer mentions that the ship's barometer was not calibrated very often. Standing NWS policy is for barometers to be calibrated as often as possible and, normally, at least once every 3 months. When in port, please contact the nearest PMO or Weather Service Office for a courtesy barometer check. If you have reason to believe that your barometer is not reading correctly, you should omit the sea level pressure group (4PPPP) from the weather message.

Cloud Type

Precipitation	As	Ns	Sc	St	Cu*	Cb*
Rain	+	+	+		+	+
Drizzle				+		
Snow	+	+	+	+	+	+
Snow Pellets			+		+	+
Hail						+
Small hail						+
Ice Pellets	+	+				
Snow grains				+		

*Showery precipitation
Very occasionally rain or snow may reach the earth's surface from Altocumulus castellanus.

New NWS Observing Handbook

A new edition of NWS Observing Handbook No. 1, Marine Surface Weather Observations has been prepared and is going through the final edit. All NWS Voluntary Observing Ships will receive a complimentary copy of the new book through the mail. Observing Handbook No. 1 describes in detail the methods and procedures for weather observing and coding aboard ship. Chapters 1 (Program Description), 2 (General Observing Practices), and 4 (Transmitting The Observation to The NWS) are new. Chapter 3 (Ships' Synoptic Code With Observing Instructions) is a revision and update of the old chapter 2. Other new features include a Glossary and a Synoptic Code Quick Reference in appendices A and B respectively.

Award Selections Underway

Recommendations for Voluntary Observing Ship outstanding performance awards are now being made by Port Meteorological Officers. The awards are for cooperation with NWS and observations taken during 1990. PMO's submit award selections to NWS Headquarters, where the final decisions are made. Only a very small number of vessels (less than 30) receive awards. The

awards program only recognizes the very best and most conscientious vessels. As in the past, the award consists of a special engraved plaque. Names of award recipients, with photo's when possible will be published in the MWL.

New Recruits
January – March, 1991

The Port Meteorological Officers recruited 54 vessels as weather observers in the Voluntary Observing Ship program during January, February and March of 1991. We thank these vessels for joining the program.

NATIONAL WEATHER SERVICE VOLUNTARY OBSERVING SHIP PROGRAM

NEW RECRUITS FROM 01-JAN-91 TO 31-MAR-91

NAME OF SHIP	CALL	AGENT NAME	RECRUITING PMO
ADRIANE-E	C6FG	SOUTHERN STEAMSHIP	JACKSONVILLE, FL
AL AHMADIAH	HZLG	KERR STEAMSHIP CO.,INC.	NEWARK, NJ
AMER HIMALAYA	P3SG3	COOL CARRIERS	LOS ANGELES, CA
AMERICANA	LADX2	IVARAN AGENCIES,INC.	NEWARK, NJ
ANNA MAERSK	OYKS2	MAERSK	SEATTLE, WA
AROSIA	J8IE	DOHLE,PETER,SCHIFFAHRTS	LOS ANGELES, CA
CAPE DIAMOND	WMHJ	MARINE TRANSPORT LINES	SAN FRANCISCO, CA
CAPE HUDSON	KMJN	INTEROCEAN MANAGEMENT CORP.	NORFOLK, VA
CHINA GLORY	XYFC	LASCO SHIPPING CO	SEATTLE, WA
CHINA PRIDE	XYFE	LASCO SHIPPING CO	SEATTLE, WA
CONSENSUS SEA	LAUW2	NORDENFJELDSKE	HOUSTON, TX
COURIER	KCBK	VULCAN CARRIERS LTD	HOUSTON, TX
DAN MOORE	WTW672	CAPE FEAR COMMUNITY COLLEGE	NORFOLK, VA
DEL MONTE HARVESTER	ELIT8	DEL MONTE FRESH FRUIT INTNL	JACKSONVILLE, FL
DIAMOND STATE	WLRL	INTEROCEAN MANAGEMENT CORP.	NORFOLK, VA
DIXIE	LAQA2	BORGESTAD-REIM SHIPPING AS	LOS ANGELES, CA
EDYTH.L.	ZCAM4	CAPES SHIPPING AGENCIES	NEWARK, NJ
EQUALITY STATE	WLRK	INTEROCEAN MANAGEMENT CORP.	NORFOLK, VA
ESSO PALM BEACH	C6HH9	EXXON INTERNATIONAL INC	NEWARK, NJ
EVER VITAL	BMCL	EVERGREEN INTERNATIONAL CORP.	NORFOLK, VA
EXXON CHARLESTON	WBVY	EXXON SHIPPING CO	NEWARK, NJ
FALCON PRINCESS	KRCP	SEAHAWK MANAGEMENT INC. ITT MACKAY	NORFOLK, VA
FRANCES.L.	ZCAM5	CAPES SHIPPING AGENCIES,INC.	NEWARK, NJ
GOLDEN GATE BRIDGE	8JGM	K LINE AMERICA INC	SEATTLE, WA
HANJIN KAOHSIUNG	DPTW	HANJIN SHIPPING COMPANY, LTD.	LOS ANGELES, CA
HANJIN LE HAVRE	D9SY	HANJIN SHIPPING COMPAN	LOS ANGELES, CA
HANJIN VANCOUVER	D9TK	HANJIN SHIPPING COMPANY, LTD.	LOS ANGELES, CA
HERACLITUS	HP2050	OCEAN EXPEDITIONS	HOUSTON, TX
ISLA PUNA	3ETX4	BIEHL & CO.	HOUSTON, TX
JAPAN RAINBOW 2	3EKL8	EAC TRANSPORT AGENCIES	SEATTLE, WA
KITTANING	KGPK	KEYSTONE SHIPPING CO.	NORFOLK, VA
LINARDOS	9HBY3	LEADERMAR AGENCY	JACKSONVILLE, FL
MC-KINNEY MAERSK	OUZW2	MAERSK LINE	NEWARK, NJ
MING AUTUMN	BLHT	FRITZ MARITIME AGENCY	SEATTLE, WA
MORELLO	DVGJ	COOL CARRIERS	LOS ANGELES, CA
MORMACSUN	WMBK	MORMAC MARINE TRANSPORT	NORFOLK, VA
NEPTUNE JACINTH	9VHQ	GENERAL STEAMSHIP CORP	SEATTLE, WA
NISSAN MARU	ELIW3	NYK LIINE	LOS ANGELES, CA
OMI STAR	KEOC	OMI CORPORATION	HOUSTON, TX
PAPAGO	VROV	ORIENT SHIP MANAGEMENT	SEATTLE, WA
POMORAC	3EIE4	JUGOSLAVENSKA OCEANSKA PLOVIDBA	LOS ANGELES, CA
RUBIN OCEAN	DUVV	MERIT STEAMSHIP AGENCY INC	SEATTLE, WA
SEA BREEZE II	3EMZ8	ABSATEX CORP	NEW YORK CITY, NY
SEALAND RELIANCE	WFLH	SEA-LAND SERVICE INC	LOS ANGELES, CA
SILVER HILL	ELFR6	MERCURY SHIPPING CO. LMTD.	BALTIMORE, MD
STRONG AMERICAN	WTF589	BENGSTEN-WALKER MARINE INC.	JACKSONVILLE, FL
SWAN CAPE	LANT2	SWAN SHIPPING A/S	JACKSONVILLE, FL
USCGC CAMPBELL	NRDC	COMMANDING OFFICER-QM SECTION	NORFOLK, VA
USCGC COURAGEOUS	NCRG	COMMANDING OFFICER-QM SECTION	NORFOLK, VA
USCGC FORWARD	NICB	COMMANDING OFFICER-QM SECTION	NORFOLK, VA
USCGC LEGARE	NRFM	COMMANDING OFFICER-QM SECTION	NORFOLK, VA
USNS RELENTLESS	NREL	MILITARY SEALIFT COMMAND	NORFOLK, VA
USNS VEGA	NYMZ	MILITARY SEALIFT COMMAND	NORFOLK, VA
YOUNG SOLDIER	D5EE	MERIT STEAMSHIP AGENCY	SEATTLE, WA

INMARSAT and Weather Reports

Forrest E. Gray
NOAA

INMARSAT equipped ships may transmit ship weather reports in World Meteorological Organization (WMO) Ship's Synoptic Code, FM 13–VIII, INMARSAT, to Coastal Earth Stations (CES). Ships select the CES based on the area they are reporting from.

For this program to remain viable, it is important for ships to transmit their reports in minimum time. Most ships transmit their reports, a full two lines of data, in **30 seconds**. Others take up to 2 minutes, costing the host country four times as much. A common reason for expensive ship reports is that the observers forget to add a group of five periods (.....) at the end of their report, thus letting the meter continue to run for no reason. Also, it should go without saying that having a complete observation before starting a transmission will save valuable transmission time.

The following is an example of a ship transmitting a ship weather report to the United States National Meteorological Center (NMC):

1. Select U.S. CES identification code 01.
2. Select routine priority.
3. Select duplex telex channel.
4. Initiate the call. Upon receipt of GA+ (Go Ahead),
5. Select the dial code for meteorological reports, 41, followed by the end of selection signal, +.
6. Upon receipt of the answerback, NWS OBS MHTS, transmit BBXX indicator, the ship's call sign, and the weather message followed by five periods. Do not send any other preamble.

Example

GA+
41+
NWS OBS MHTS
BBXX WLXX 29003 99131 70818 41998 60909 10250 2021/ 40110 52003 71611 85264 22234 00261 20201 31100 40803 .....

NOTE THE FIVE PERIODS INDICATE THE END OF THE MESSAGE

MADRID, SPAIN

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
	3650 kHz		F3C	10 KW
	6918.5 kHz		F3C	10 KW
	10250 kHz		F3C	10 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
———/1215	24HR WAVE PROG	120/576	0600	504
0105/1304	24HR 300MB PROG (1	120/576	12/00	M
0139/1338	24HR 500MB PROG (1	120/576	12/00	M
0151/1351	24HR 700MB/850MB PROGS (1)	120/576	12/00	M
0350/1545	SURFACE ANAL	120/576	0000	AP1
0402/1558	300MB ANAL	120/576	00/12	AP2
———/1610	24HR 300MB PROG	120/576	0000	CPZ
0415/———	500MB ANAL	120/576	0000	AP2
———/1620	24HR 200MB PROG	120/576	0000	CPZ
0430/———	12HR 850MB/700MB/500MB/300MB PROGS	120/576	1200	EP
———/1630	24HR 250MB TROPOPAUSE PROG	120/576	0000	CPZ
0440/1640	12HR SIGNIFICANTWEATHER PROG	120/576	12/00	EP/CPZ
———/1650	1 2HR 850MB/700MB/500MB/300MB PROGS	120/576	0000	EP
0450/———	24HR 300MB PROG	120/576	1200	CPZ
———/1650	12HR 850MB/700MB/500MB/300MB PROGS	120/576	0000	EP
0500/———	24HR 200MB PROG	120/576	1200	CPZ
———/1700	12HR SIGNIFICANTWEATHER PROG	120/576	0000	EP
0510/———	24HR 250MB TROPOPAUSE PROG	120/576	1200	CPZ
———/1710	MAX TEMP ANAL	120/576	1200	504
0520/———	1 2HR SIGNIFICANT WEATHER PROG	120/576	1200	CPZ
———/1730	WAVE ANAL (2)	120/576	1200	504
0545/———	12HR SIGNIFICANTWEATHER PROG (1)	120/576	00/12	M
———/1750	500MB ANAL	120/576	1200	AP2
0600/1810	700MB ANAL	120/576	00/12	AP2
0615/1830	850MB ANAL	120/576	00/12	AP2
0630/———	24HR500MB/850MB/1000MBPROGS	120/576	0000	AP3
0650/1904	18HR 300MB PROG (1	120/576	18/06	M
0724/1938	18HR 500MB PROG 11	120/576	18/06	M
0737/1951	18HR 700MB/850MB PROGS	120/576	18/06	M
0825/———	24HR/48HR/72HR300MB/500MB/700MB/850MBPROGS	120/576	0000	CE
0900/———	18HR 850MB/700MB/500MB/300MB PROGS	120/576	1800	EP
0910/———	12HRSIGNIFICANTWEATHERPROG	120/576	1800	EP
1015/2150	18HR 300MB PROG	120/576	18/06	CPZ
1025/2200	18HR 200MB PROG	120/576	18/06	CPZ
1035/2210	18HR 250MB TROPOPAUSE PROG	120/576	18/06	CPZ
1045/2220	12HR SIGNIGICANT WEATHER PROG	120/576	18/06	CPZ
———/2230	18HR 850MB/700MB/500MB/300MB PROGS	120/576	0600	EP
———/2240	18HR SIGNIFICANT WEATHER PROG	1200/576	0600	EP
1105/———	WAVE ANAL	120/576	0600	504
1120/———	24HR SURFACE PROG	120/576	1200	AP1

NOTES:
(1) REBROADCASTOF OFFENBACH/MAIN BROADCAST. TRANSMISSION TIMES APPROXIMATE
(2) NOT ON SUNDAY.

MAP AREAS:						
AP1	- 1:10,000,000	59N	041W,63N	021E,27N	018W,27N	OO9E
AP2	- 1:15,000,000	50N	045W,58N	016E,26N	027W 27N	010E
AP3	- 1:20,000,000	35N	042W,54N	031E,25N	026W,28N	020E
CE	- 1:24,000,000	51N	078W,51N	059E,32N	OO9W,O9N	012W
EP	- 1:13,000,000	45N	015W,45N	OO9E,33N	032W,34N	007E
154	- 1:07,500,000	52N	031W,50N	030E,26N	024W,23N	017E
504	- 1:10,000,000	48N	054W,65N	016E, 15N	023W, 18N	026E
M	- 1:15,000,000	51N	046W,56N	060E,25N	017W,27N	033E

(INFORMATION DATED 01/1991)

WELLINGTON, NEW ZEALAND

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
ZKLF	5806.6 kHz	CONTINUOUS	F3C	5 KW
	9458.6 kHz	CONTINUOUS	F3C	5 KW
	13550.1 kHz	CONTINUOUS	F3C	5 KW
	16340.1 kHz	CONTINUOUS	F3C	5 KW

(INFORMATION DATED 01/1991)

PEARL HARBOR, HAWAII, U.S.A.

CALL SIGN	FREQUENCIES	TIMES		EMISSION	POWER
NPM	4855 kHz	0600-1600*	LSB/ISB	F3C	
	6453 kHz	0000-2359&	USB/ISB	F3C	
	8492.5 kHz	0000-2359#	USB	F3C	
	9090 kHz	0000-2359&	USB/ISB	F3C	
	9396 kHz	1600-0600*	LSB/ISB	F3C	
	21837 kHz	0000-2359*	USB/ISB	F3C	

* PEARL HARBOR FREQUENCIES # ADAK AK FREQUENCY & STOCKTON CA FREQUENCIES

TRANS	TIME CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0000/———	FFAX SCHEDULE (WED & SAT)	120/576		
	SEA SURFACE TEMP ANAL (HAWAII AREA) (SUN)	120/576	—-/12	6
	SEA SURFACE TEMP ANAL (SWPAC) (MON)	120/576	—-/12	7
	STORM TRACK (TUE)	120/576	—/—	8
	SEA SURFACE TEMP ANAL (SOUTHERN CAL) (THU)	120/576	—-/12	9
	SONIC LAYER DEPTH (WPAC) (FRI)	120/576	—-/12	
———/1200	48HRSIGNIFICANTWAVEPROG(EPAC)	120/576	00/—-	2
0015/———	FFAX SCHEDULE (WED & SAT)	120/576		
	SEA SURFACE TEMP ANAL NORTHERN CAL) (SUN & THU)	120/576	—-/12	10
	SEA SURFACE TEMP ANAL NWPAC) (MON)	120/576	—-/12	11
	SATELLITE IMAGERY (GMS 3-SECTOR) (T~IE)	120/576	2100	
	SONIC LAYER DEPTH (EPAC) (FRI)	120/576	—-/12	2
———/1215	SATELLITE IMAGERY GOES C-SECTOR IR)	120/576	1159	
0030/———	SATELLITE IMAGERY GOES C-SECTOR VISUAL)	120/576	2359	
———/1230	36HR SURFACE PROG (SRN HEMIS)	120/576	—-/12	
0045/1245	SIGNIFICANT WAVE ANAL	120/576	12/00	3
0100/1300	12HR SURFACE PROG	120/576	00/12	4
0115/1315	24HR SURFACE PROG	120/576	12/00	4
0130/1330	24HR 850MB PROG (EPAC	120/576	12/00	2
0145/1345	24HR 700MB PROG EPAC	120/576	12/00	2
0200/1400	24HR 400MB PROG ~EPAC	120/576	12/00	2
0215/1415	24HR 300MB PROG ~EPAC	120/576	12/00	2
0230/1430	24HRSIGNIFICANTWAVE'ROG(WPAC)(2)	120/576	12/00	
0245/1445	SATELLITE IMAGERY (GMS B-SECTOR)	120/576	23/11(3)	
0300/1500	24HR SIGNIFICANTWAVE PROG (WPAC) (2)	120/576	12/00	
0315/1515	24HR 850MB PROG (WPAC)	120/576	12/00	
0330/1530	PRELIMINARY SURFACE PhOG (EPAC)	120/576	00/12	2
0345/1545	PRELIMINARY SURFACE PROG (WPAC)	120/576	00/12	
0400/1600	24HR 700MB PROG (WPAC)	120/576	12/00	
0415/1615	24HR 400MB PROG WPAC)	120/576	12/00	
0430/1630	24HR 300MB PROG ~WPAC)	120/576	12/00	
0445/1645	24HRSIGNIFICANTWAVEH-VISPROG	120/576	12/00	3
0500/1700	48HR SIGNIFICANT WAVE H-VIS PROG	120/576	12/00	3
0515/———	24HR 500MB SL PROG	120/576	12/—-	3
———/1715	72HR SURFACE PROG (EPAC)	120/576	—-/00	2
0530/———	48HR 500MB SL PROG	120/576	12/—-	3
———/1730	72HR SURFACE PROG (WPAC)	120/576	—-/00	
0545/1745	TROPICALWARNINGS/OPEN PERIOD	120/576	—/—	
0600/———	SATELLITE IMAGERY GOES C-SECTOR IR)	120/576	0529	
———/1800	SATELLITE IMAGERY GOES C-SECTOR VISUAL)	120/576	1759	
0615/1815	FINAL SURFACE ANAL	120/576	00/12	5
0700/1900	500MB ANAL (EPAC)	120/576	00/12	2
0715/1915	500MB ANAL ~WPAC)	120/576	00/12	
0730/1930	24HR SURFACE PROGEPAC)	120/576	00/12	2
0745/1945	24HR SURFACE PROG (WPAC)	120/576	00/12	
0800/2000	48HR SURFACE PROG (EPAC)	120/576	00/12	2
0815/2015	48HR SURFACE PROG (WPAC)	120/576	00/12	
0830/2030	36HR SURFACE PROG(EPAC)	120/576	00/12	2
0845/2045	36HR SURFACE PROG (WPAC)	120/576	00/12	
0900/———	SATELLITE IMAGERY (GOES C-SECTOR IR)	120/576	0859	
———/2100	SATELLITE IMAGERY ~GOES C-SECTOR VISUAL))	120/576	2031	
0915/2115	PRELIMINARY SURFACE ANAL (EPAC)	120/576	06/18	2
0930/2130	PRELIMINARY SURFACE ANAL ~WPAC)	120/576	00/12	
0945/2145	24HR 500MB PROG (EPAC)	120/576	00/12	2
1000/2200	24HR 500MB PROG ~WPAC)	120/576	00/12	
1015/2215	48HR SURFACE PROG (EPAC)	120/576	00/12	2
1030/2230	48HR SURFACE PROG ~WPAC)	120/576	00/12	
1045/———	SATELLITE IMAGERY (GMS B-SECTOR)	120/576	0928	
1100/2245	36HR SURFACE PROG BLEND	120/576	12/00	
1130/2315	SIGNIFICANTWAVEANAU36HRSIGNIFICANTWAVEPROG	120/576	00/12	2
1145/2330	24HR SIGNIFICANT WAVE PROG (EPAC)	120/576	00/12	2
———/2345	48HR SIGNIFICANTWAVE PROG ~EPAC~	120/576	—-/12	2

MAP AREAS: CHART PROJECTION ASSUMES A 19 INCH RECORDER.

1	- 1:13,000,000	60N 123E,	60N 162W,	05N 123E,	05N 162W
2	- 1:13,000,000	60N 168W,	60N 093W,	05N 168W,	05N 093W
3	- 1:05,000,000	38N 100E,	42N 080W,	EQ 160E,	EQ 140W
4	- 1:05,000,000	55N 110E,	60N O90W,	30N 165E	28N 140W
5	- 1:13,000,000	60N 150E,	60N 110W,	05N 150E,	05N 110W
6	- 1:05,000,000	12N 170W,	40N 170W,	EQ 145W,	30N 135W
7	- 1:05,000,000	EQ 170E,	34N 160E,	05N 165W,	38N 165W
8	- 1:05,000,000	60N 110W,	60N 115W,	EQ 110E,	EQ 115W
9	- 1:05,000,000	25N 135W,	45N 120W,	15N 120W,	25N 105W
10	- 1:05,000,000	35N 170E,	65N 170W,	30N 140W,	50N 115W
11.	– 05,000,000	30N 160E,	50N 135W,	30N 165W,	65N 165W

NOTES:
1. CONTENTS OF THIS SCHEDULE MAY CHANGE WITHOUT NOTICE DUE TO U.S. NAVY OPERATIONAL REQUIREMENTS
2. ARROW HEADS INDICATE PRIMARY DIRECTION, ARROW TAILS INDICATE SECONDARY DIRECTION.
3. ACTUAL TIMES ON THE HALF HOUR.
4. COMMENTS CONCERNING QUALITY AND CONTENT ARE SOLICITED. ADDRESS COMMENTS TO: NAVAL WESTERN OCEANOGRAPHY CENTER BOX 1 13 PEARL HARBOR, Hl 96860-5050

(INFORMATION DATED 02/1991)

Forecasting Hurricane Waves

Professor S.A. Hsu
Coastal Studies Institute
Louisiana State University

(While this piece is more technical than we usually publish in the Log, the mathematics are fairly simple and the results indicate the importance of wave observations in research and forecasting —ed)

This short research note is an attempt to develop a simpified formula for forecasting a hurricane's maximum significant wave height from its minimum central pressure projection. It was motivated by a Glenn Hamilton article, which showed that in R.B. Long's method for estimating significant wave heights large discrepancies resulted between measured heights and those predicted. One reason for this may be that when hurricanes are close to land, the wind speed is less representative than the central pressure.

Under hurricane conditions, a third generation wave model (WAM) has been used successfully to hindcast the significant wave heights in the Gulf of Mexico. Because tropical storms are generally fetch–limited, the non–dimensional fetch parameter for WAM overlaps the JONSWAP (Joint North Sea Wave Project) wave formulation. Therefore the simplified JONSWAP wave model should also be useful. Formula no. 1 represents the non–dimensional wave height versus the non–dimensional wave fetch while no. 2 is the non–dimensional wave period versus the non–dimensional wave fetch.

(1) $$\frac{gH_s}{U^2_{10}} = 1.6 \times 10^{-3} \sqrt{\frac{gF}{U^2_{10}}}$$

(2) $$\frac{gT_m}{U^2_{10}} = 2.857 \times 10^{-1} \sqrt[3]{\frac{gF}{U^2_{10}}}$$

g	gravitational acceleration
H_s	significant wave height
F	fetch
U_{10}	windspeed at 10 meters above the surface.
T_m	peak spectral period such that $T_p = 0.95T_m$, where T_p is the significant wave period related to H_s.

The idea is to eliminate the fetch, which is a troublesome parameter. It has been shown that, under hurricane conditions, the wave steepness can be written:

$$H_s/gT^2_m = 0.0068$$

So to eliminate the fetch, we divide equation no. 1 by the square of equation no. 2 and substitute the steepness factor. We then have:

(3) $$(gF/U^2_{10}) = 573.78$$

By substituting no. 3 into no. 1 then:

(4) $$H_s = 3.91 \times 10^{-3} U^2_{10}$$

As a test of equation no. 4 we use the windspeed of 58 m/s measured on an offshore drilling rig during Camille in 1969. If you substitute this value into equation no. 4 you obtain H_s = 13.2 m, which is in good agreement with the measured value of 13.6 m as quoted in table 5 of the WAMDI Group Report.

A popular formula, which relates the maximum sustained surface wind (V_{max}) and the pressure gradient is:

(5) $$V_{max}(m/s) = 7.22\sqrt{1013 - P_0}$$

where P_0 is the sea level pressure (mb) at the storm center. The pressure value of 1013 mb represents conditions near the outer edges of the hurricane. If you equate U_{10} (the windspeed at 10 meters above the sea surface), to V_{max} and substitute the V_{max} equation no. 5 into equation no. 4 and convert meters to feet then:

(6) $$H_s\,(ft) = 0.66\,(1013 - P_0)$$

To verify equation no. 6, take a look at the table for two extreme records of significant wave height as mea-

sured by buoys in 1985. It can be seen that using the central pressure method in equation no. 6 looks better than the wind speed method as proposed by Long in the Mariners Weather Log, 1979. The main purpose of equation no. 6 is to forecast the maximum significant wave height induced by a hurricane if its minimum central pressure projection is available whereas the Long's method may be used to estimate significant wave height if the wind speed at a given location from the storm is known. Certainly, more pertinent data are needed to further evaluate these simple methods.

Hurricane	Station	Central Pressure	Measured Hs	Computed Hs from Eq. No. 6	Computed Hs from Ross–Long
Gloria	41002	942 mb	46.9 ft	46.9 ft	27.6 ft
Kate	42003	956 mb	35.1 ft	37.6 ft	30.1 ft

References

Atkinson, G.D., **Forecaster's Guide to Tropical Meteorology**, Technical Report 240, Air Weather Service, U.S. Air Force, 1971.

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Hamilton, G.D., **Buoy Records Set in 1985 Hurricanes**, *Mariners Weather Log*, Vol. 31, No. 4 (1987).

Hsu, S.A., **Coastal Meteorology**, Academic, San Diego, CA, 1988

Long, R.B., **Forecasting Hurricane Waves**, *Mariners Weather Log*, Vol. 23, No. 1 (1979)

The WAMDI Group, **The WAM model — a third generation prediction model**, *Journal of Physical Oceanography*, 18,

Northern Hemisphere Tropical Cyclone Names — 1991 Season

North Atlantic	E. North Pacific	W. North Pacific	
Ana	Andres	Sharon	Orchid
Bob	Blanca	Tim	Pat
Claudette	Carlos	Vanessa	Ruth
Danny	Dolores	Walt	Seth
Erika	Enrique	Yunya	Thelma
Fabian	Felicia	Zeke	Verne
Grace	Guillermo	Amy	Wilda
Henri	Hilda	Brendan	Yuri
Isabel	Ignacio	Caitlin	Zelda
Juan	Jimena	Doug	
Kate	Kevin	Ellie	
Larry	Linda	Fred	
Mindy	Marty	Gladys	
Nicholas	Nora	Harry	
Odette	Olaf	Ivy	
Peter	Pauline	Joel	
Rose	Rick	Kinna	
Sam	Sandra	Luke	
Teresa	Terry	Mireille	
Victor	Vivian	Nat	
Wanda	Waldo		

Central North Pacific Tropical Cyclones —1990

Andy Chun
CPHC, NOAA

Only two tropical cyclones were classified within the Central North Pacific Hurricane Center's area of responsibility in 1990. There were also two intruders from the eastern North Pacific.

Tropical Storm Aka

Aka was the first tropical cyclone of the 1990 season to develop in the central North Pacific. A disturbed area of weather became increasingly organized and, by the 6th of August, began to show signs of becoming a tropical cyclone.

The first advisory was issued at 2100 UTC on the 7th. One–C quickly gained strength, and was upgraded to Tropical Storm Aka by 0300 UTC on the 8th. The tropical storm moved westward, staying well south of the Hawaiian Islands. The closest point of approach to South Point, Hawaii was 500 miles due south at 0000 UTC on the 9th.

Aka reached its peak intensity of 55 knots near 11°N, 165°W early on the 10th. Its track was well south of what climatology dictated, but it did begin to move more toward the west northwest and passed about 225 miles south of Johnston Island at 0900 UTC on the 11th. Aka crossed the International Dateline on the 13th and passed south of Wake Island as a dissipating tropical depression on the 15th.

Tropical Depression Two–C

Two–C was the second and only other tropical cyclone to be classified in the central North Pacific this season. A disturbance was labeled Two–C at 1800 on the 10th of August. It moved westward and then west southwestward until 0600 on the 12th, when it returned to a westerly movement. Hurricane reconnaissance aircraft flew a low level investigative mission on the 12th but could find no identifiable circulation.

Hurricane Marie

Hurricane Marie crossed into the central North Pacific, from the east, at 0600 UTC on the 14th of September. Maximum sustained winds were estimated at 100 knots. During this time, Marie was being drawn northward by a trough in the mid latitudes and began to weaken.

Two days later a tropical storm watch was issued for the Big Island of Hawaii, when Marie was 340 miles to the east southeast of Hilo. In addition a high surf advisory was issued for the southeast shores of the Big Island. Marie was downgraded to a tropical storm at 0660 UTC on the 17th, but had moved to within 230 miles of Hilo later in the day, so the watch was upgraded to a warning. During this period, an upper level anticyclone moved between the storm and the mid–latitude trough to the north and began to steer Marie toward the west southwest. Marie was downgraded to a tropical depression at 0000 UTC on the 19th.

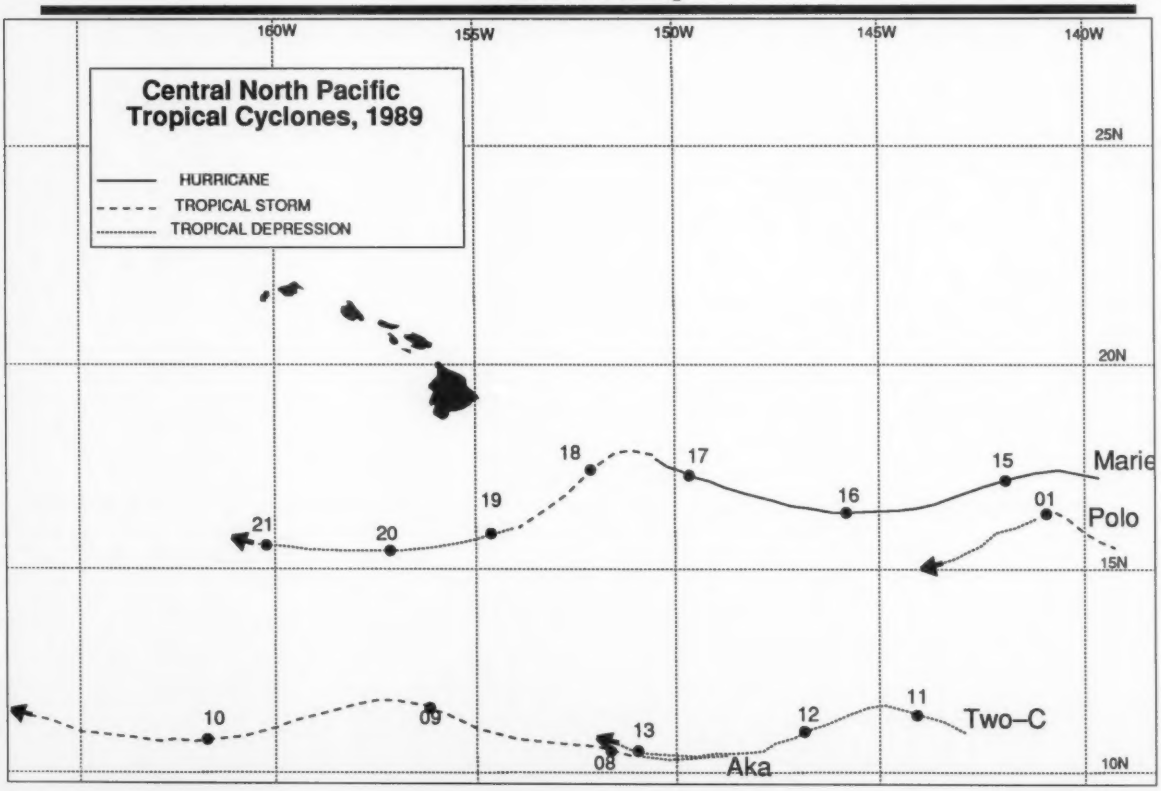
Tropical Storm Polo

Polo crossed into the central North Pacific near 16°N, 140°W at 0000 on the 1st of October. Maximum sustained winds at this time were estimated at 50 knots, but the storm was weakening. As the result of shearing aloft from strong southwest winds, Polo was downgraded to a tropical depression by 1200 and continued to dissipate as it passed far to the southeast of Hawaii.

Central North Pacific Tropical Cyclone Summary, 1989

Name	Dates	Classification in Cen. Pacific	Max.Winds est (Kn)
Aka	7–13 Aug.	Tropical Storm	55
Two–C	10–13 Aug	Tropical Depression	30
Marie	14–21 Sept.	Hurricane	100
Polo	1–2 Oct.	Tropical Storm	50

Data pertain only to that portion of the time the tropical cyclone was in the Central North Pacific (140°W to 180°).


Central North Pacific
Tropical Cyclones, 1989
HURRICANE
TROPICAL STORM
TROPICAL DEPRESSION
160W
155W
150W
145W
140W
25N
20N
15N
10N
Marie
Polo
Two-C
Aka
01
09
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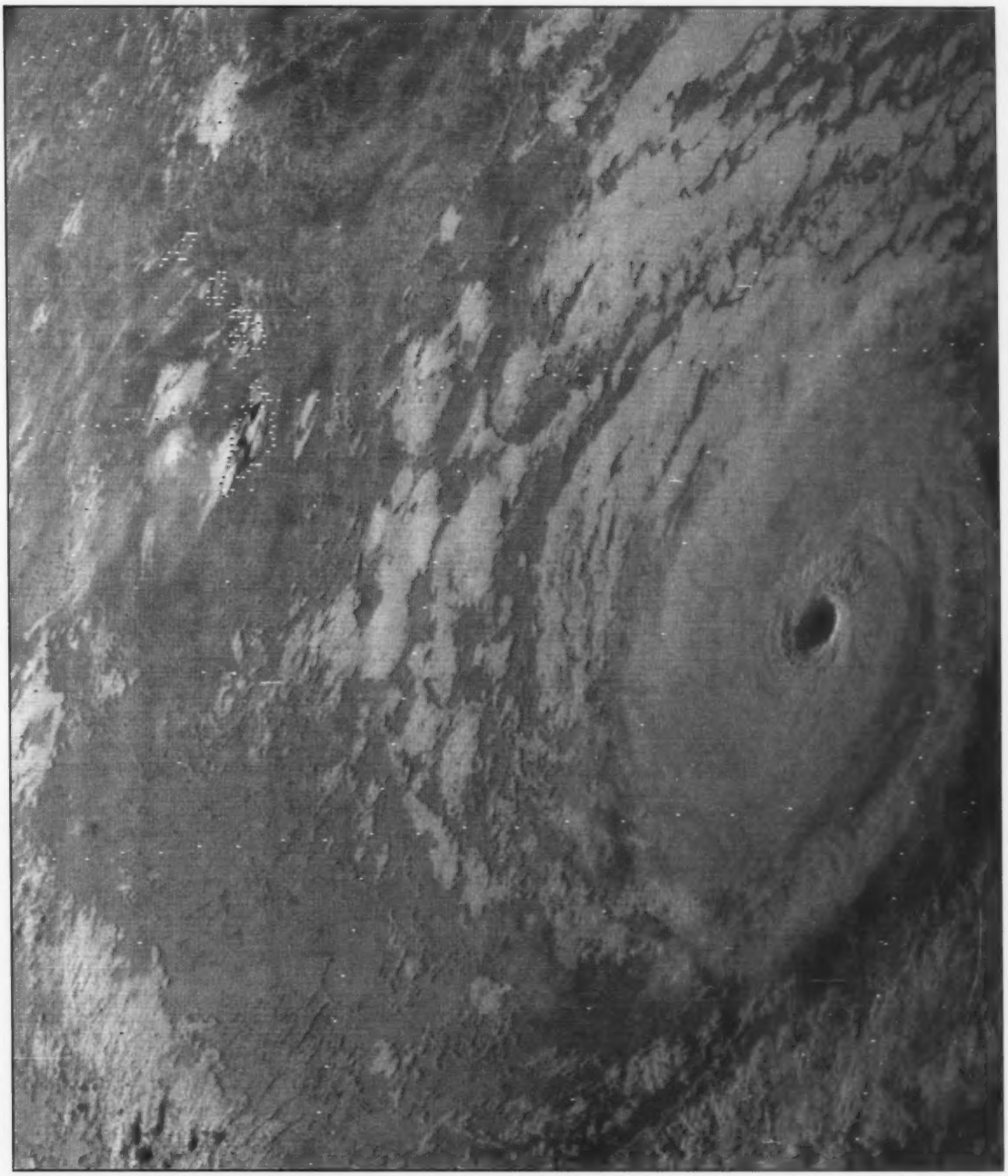


Good–looking Hurricane Marie (left) sports 100–knot winds after crossing into the central region. Above, Marie also shows off a large, well–defined eye in the evening shadows on the 15th. Marie remained at hurricane strength through 1200 on the 16th, after resuming a course toward the west northwest.

North Atlantic Weather October, November and December 1990

October— There were no doubts about the climatic features known as the Icelandic Low and Azores High this October (fig 1). The High was close to normal, while the Low was intense and east of its normal position. This resulted in negative anomalies of as much as –6 hPa over the British Isles and surrounding seas. In the upper levels, north of 40°N, the steering patterns were nearly zonal except east of 15°W where they turned northeastward.

On this Date

October 16, 1960— Mr. Juan A. Sanchez, Second Officer, aboard the ***Almirante*** took this waterspout photograph (fig 2) off the entrance to the Mississippi River near Southwest Pass Sea Buoy.

Ocean Weather

Hurricane season was in full swing and Josephine was coming to life as the month opened. (See the annual summary beginning on pg 16.) In the more northerly latitudes a 954–hPa Low was southwest of Iceland and heading east southeastward, while a 972–hPa Low flared up briefly over the Great Lakes on the 2d.

A low off Newfoundland late on the 2d trailed a cold front to the south, and ships along this front were reporting winds in the 40–kn (74 km/h) range near Grand Banks. These vessels included the ***Queen Elizabeth 2***, OUJH2, and the UUDV. Meanwhile, the Iceland Low and another from the region south of Greenland combined to cause some weather problems over the British Isles and surrounding seas. On the 4th, several vessels in the North Sea hit winds in the 40–to–50 kn (74 – 93 km/h) range in 5–to 8–ft (1.5-2.4 m) seas. These conditions lasted into the 5th.

The following day the remnants of Josephine were crossing the 40th parallel while tropical storm Klaus was coming to life among the Windward Is. A few days later Lili came to life, and over the northern shipping lanes a 975–hPa storm and its trailing cold front were harassing ships over the eastern North Atlantic, Norwegian and North Seas. For example, on the 9th, at 0600, the ***Frithjof*** hit 55–kn (102 km/h) west southwesterlies near 61°N, 1°E. By 0000 on the 10th, the storm's central pressure dipped to 961 hPa near the North Cape of Norway. While this is far north of most shipping, its active cold front trailed through the Baltic Sea and out into the Bay of Biscay. Winds in the 40–to 55–kn (70 – 102 km/h) range were still being encountered. At 0600 on the 10th the ***Kapitan Sviridov*** (71°N, 28°E)

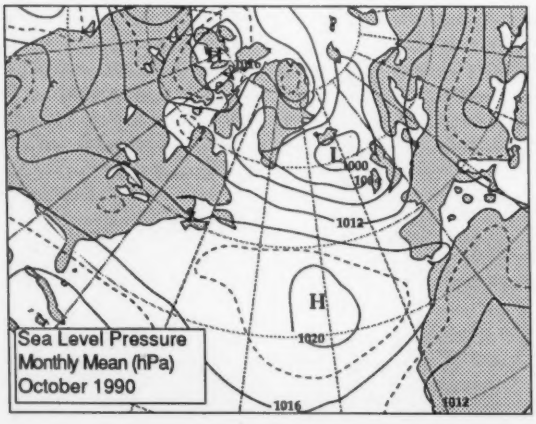


Figure 1.— The Icelandic Low was east of its normal position in October and this led to anomalies of –6 hPa over the British Isles. The analysis was provided by Vernon Kousky and John Kopman.

Figure 2.— This was but one of a number of waterspouts that was sighted in the Gulf of Mexico, off Southwest Pass, on the 16th of October 1960. As can be seen by the clear sky, these were fair–weather spouts.

reported a 973–hPa pressure in 40–kn (74 km/h) east northeasterlies while battling 20–ft (6m) seas.

Several minor Lows along with Hurricane Lili and Tropical Storm Marco dominated the weather charts for the next several days. One of these Lows developed into a potent storm off the British Isles on the 12th.

1 This system was traced back to Gulf of St. Lawrence on the 10th. However, it moved rapidly eastward and by the following day was a 984–hPa storm crossing the 30th meridian near 48°N. It then swung northeastward and continued to deepen. By 1200 on the 12th, its 968–hPa center was crossing the 60th parallel near 15°W. The C4VG (62°N, 16°W) summed up the intensity with a report of 68–kn (126 km/h) northerlies and a 967–hPa pressure. The ***Laxfoss*** (61°N, 11°W) ran into a 52–kn (96 km/h) southerly and a 980–hPa pressure. The C4VG seemed to be in conditions of 60 kn (111 km/h) plus winds from 0600 and reported every 3 hr. An indication of seas was provided by the ***Stakhanovets*** with a report of 13 ft (4 m) at 1200. Six hours later the ***Maritta Johanna*** ran into 50–kn (93 km/h) south southeasterlies near the Atlantic entrance to the English Channel. The ***Greenland Saga*** (63°N, 10°W) was blasted by 40–ft (12 m) seas in 52–kn (96 km/h) southerlies. This was a potent storm. A secondary Low was forming along its stationary front and this was creating problems south to the Bay of Biscay. A rash of ship reports at 1200 on the 13th indicated winds in the 40– to 50–kn (74 – 93 km/h) range (fig 3). The Low had actually become the dominant circulation at this time and it was not done yet (fig 4). By the 14th, its central pressure plummeted to 963 hPa as it cruised northward to the west of the British Isles. While there weren't many ship reports, the ones that came in established the severity of this system. At 1200 the ***Nikki Ittuk*** (58°N, 18°W) ran into 60–kn (111 km/h) winds and a 963–hPa pressure. If this weren't enough, she was battling 30–ft (9 m) seas as well. Winds of 50 to 60 kn (93–111 km/h) were entirely reasonable in this near–monster. Fortunately it fizzled as rapidly as it had intensified.

The weather charts at mid month were about as placid looking over the North Atlantic as any for October. It wasn't until the 18th, when a 978–hPa storm flared up briefly southeast of Kap Farvel, that there was any weather of consequence. A large high built over the south central North Atlantic and by the 20th Hurricane Nana was coming to life near 30°N, 65°W. A mean looking system had also developed over Newfoundland at this time. This storm moved out into the Atlantic on the 21st and

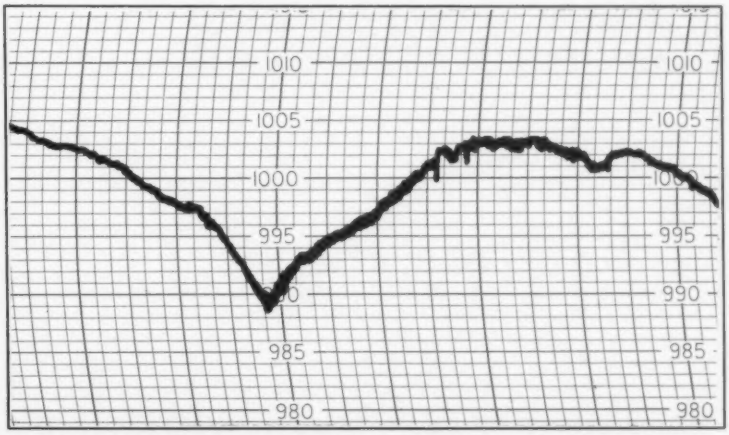


Figure 3.— The Sonora on her way from Bremen to LeHavre, ran across storm no. 1 on the 13th. Her pressure dipped to near 988 hPa.

Satellite Data Services Division

Figure 4.— In this NOAA visual shot at 1230 on the 12th, the Low can be seen near Iceland with a front moving into the British Isles.

created some problems for shipping over western waters. A tight gradient and an active cold front added to the problems. On the 21st gales were being reported between 40° and 50°N from about 35° to 50°W. This situation was short lived and by the 23d there was a respite over much of the ocean.

A large, sprawling High built over the south central North Atlantic for the remainder of the month, although there was some cyclonic activity off the East Coast of the United States and from Greenland to England. On the 26th, a Low developed off Cape Hatteras, NC, and created havoc on both sides of the Atlantic.

2 This system actually developed in the wake and along the front of a previous storm. On the 26th, several vessels off the Outer Banks encountered winds in the 40– to 50–kn (74–93 km/h) range with seas up to 20 ft (6 m). For example, the WENW (37°N 75°W) hit 50–kn (93 km/h) northerlies in 20–ft (6 m) seas at 1200. The storm moved east northeastward as its central pressure dipped to 984 hPa on the 27th and then filled somewhat the following day as it crossed the 50th parallel near 35°W. It was skirting the north side of the huge 1032–hPa High.

In the meantime, a couple of low pressure systems extended from Iceland to England and were already creating weather problems in the region. The additional impetus of this Cape Hatteras Low added fuel to the fire. By 0000 on the 29th, a 959–hPa pressure was analyzed just each of Inverness, Scotland. Winds in the North and Norwegian Seas had been running in the 45–to 50–kn (83–93 km/h) range on the 28th. For example, at 1200 the GBXW (57°N, 1°E) hit 52–kn (96 km/h) winds and 970–hPa pressure in 18–ft (5 m) seas. There were a dozen other reports to confirm this. These conditions continued through the 29th but abated somewhat by the 30th. The month closed on a less severe note.

Casualties

The Outer Banks of North Carolina suffered a blow when the Bonner Bridge across Oregon Inlet, was damaged by the dredge ***Northerly Island*** (see pg 4 for full story). In southern counties of England and Wales, on the 20th and 21st, gales and heavy rain disrupted traffic and caused widespread flooding. Winds gusted to 63 kn (119 km/h) at Sheerness and 69 kn (130 km/h) at Portland Bill. Two people lost their lives.

Tropical Storm Marco was responsible for some damage from Florida to New England. On the 4th, an intense Low moved over Hudson Bay and pushed a frontal

system across Maine. This caused some minor damage. South Carolina suffered beach erosion on the 10th due to high tides; tropical systems added to those tides. The 1289–ton ***Century*** was reported to have capsized near 31°N, 71°W in Hurricane Lili.

November— The Icelandic Low was centered off the tip of Greenland (fig 5), which created 6–hPa negative anomalies from Kap Farvel to the Grand Banks. A ridge of the Azores – Bermuda High pushed northward into the Norwegian Sea creating positive anomalies over the eastern North Atlantic. Aloft, the steering patterns reflected these features and the flow was east northeastward to northeastward over the western ocean, turning back toward the east southeast over western Europe.

On This Date

November 26, 1964— On Thanksgiving Day in a heavy pre–frontal fog 17 mi (31 km) off Barnegat Light, the Israeli luxury liner ***S.S. Shalom*** (fig 6) sliced through the Norwegian tanker Mv ***Stolt Dagali***. The 140–ft (43 m) stern section of the tanker sank with the loss of 19 crewmen. U.S. Coast Guard cutters, four merchant vessels and a fleet of Navy and Coast Guard helicopters rescued 24 crewmen from aboard the tanker.

*Figure 6.— The S.S. **Shalom** has a 40–ft (12 m) gash on her starboard after a Nov 26, 1964 collision in fog with the Norwegian tanker Mv **Stolt Dagali**, whose 440–ft (134 m) bow section was towed to New York.*

Ocean Weather

The month opened with a 975–hPa storm off Labrador. It had begun to develop in the last part of October over the Grand Banks, but didn't really get organized until the beginning of November. It was not a particularly intense storm, but it dominated the weather picture over the western portion of the northern shipping lanes for several days. In the meantime, a high pressure system was building off the mid Atlantic Coast of the U.S. and eventually combined with a tropical high to blanket most of the south central North Atlantic.

On the 5th a Low from Arkansas moved northward and intensified as it approached the Great Lakes. At 0000 on the 6th the ***J. Burton Ayers*** hit 50–kn (93 km/h) northeasterlies on Lake Huron. Winds of 40 to 45 kn (74 – 83 km/h) were also reported by the ***Mesabi Miner*** and the WURR 885. Three hours later the VGWM ran into 58–kn (107 km/h) west southwesterlies on Lake Ontario as the storm headed northeastward. The ***William J. Delancey*** hit 56–kn (104 km/h) north northwesterlies at 0600 on southern Lake Huron. This system eventually made it into

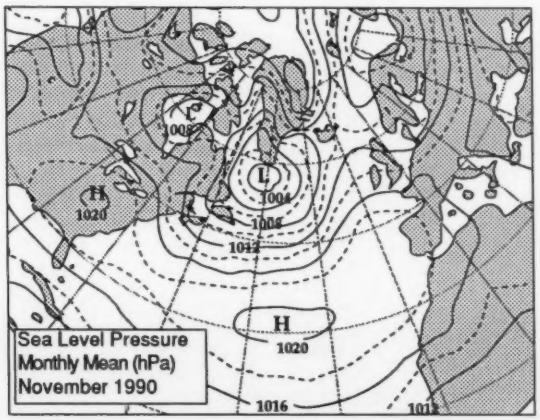
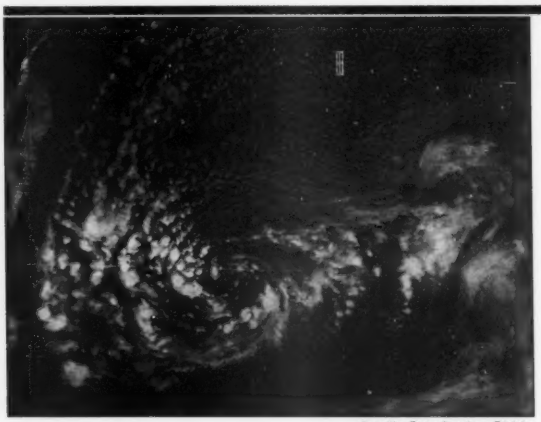


Figure 5.— The Icelandic Low is forced off the southern tip of Greenland by the intrusion of the Azores–Bermuda High over the Norwegian Sea. This is reflected in the paths of the storms for the month. The analysis was provided by Vernon Kousky and John Kopman.



Satellite Data Services Division

Figure 7.— The marker is located at 45°N, 40°W on the 10th. At 1800 on the 9th, the SQLF was belted by 55–kn (102 km/h) southerlies and registered a 969–hPa pressure near 48°N, 41°W.

the Atlantic on the 7th. It continued eastward along the 45th parallel and turned toward the east northeast on the 8th. By 1200, the central pressure had dipped to 973 hPa. There were several other centers embedded within a huge circulation that covered almost the entire North Atlantic north of about 40°N. It was, however, another storm that was just intensifying south of Nova Scotia that became dominant.

1 This system can be traced back to the 3d in the southern Bahamas. It developed along the trailing end of a cold front from the northern latitudes. It was well documented even in these early stages. At 1200 on the 4th the ***Mormacsun***, some 180 mi north of the center, reported 35–kn (65 km/h) winds in a heavy shower and the ***Challenger*** ran into 15–ft (5 m) swells east of the center. The incipient system meandered through the Bahamas on the 5th and just about washed out the following day. It remained as a weak trough for several days and was finally re–energized on the 8th by a wave from off the East Coast of the U.S. By the 9th, it was an organized 981–hPa Low following in the wake of the previous system (fig 7). The ***Bonn Express*** (40°N, 36°W) ran into 56–kn (104 km/h) southwest winds at 0600 on the 10th. The storm's central pressure was estimated at 958 hPa at 0000 on the 10th, and its active cold front was generating gales to 35°N. The storm continued northeastward and its power was felt through the 10th (fig 8). For example, at 1500 the CGDV (47°N, 49°W) came in with a 58–kn (107 km/h) north northwesterly in 14–ft (4 m) seas. However, the system began to fill on the 11th, while another storm was intensifying south of Cape Cod. Not that this storm was finished. Its 980–hPa center continued northeastward and then jogged around Iceland on the 15th. At this point it absorbed the Cape Cod storm and became a potent 960–hPa Low over the Greenland Sea. It remained intact until about the 19th.

2 The Cape Cod Low really came from a Low over Lake Erie and another over Mexico. The Mexican system can be traced back to the 8th. After crossing the northwestern Gulf of Mexico and the southeastern U.S., it hugged the East Coast and deepened rapidly on the 11th. This was about the time that a secondary, but separate, center was coming to life over Lake Erie. At 0000 on the 12th the Mexican Low was over the Gulf of St Lawrence sporting a 956–hPa center. The ***Wladyslaw Sikorski*** (43°N, 61°N) was raked by 65–kn westerlies while battling 22–ft seas. In general, vessels were reporting winds in the 40– to 50–kn (73–93 km/h) range, south of the center. The circulation was affecting weather on the Great Lakes as well, where winds in the 40– to 50–kn (73–93 km/h) range were reported by such vessels as the ***George A. Stinson, Herbert C. Jackson*** and the ***Edgar B. Speer.***

Meanwhile the Lake Erie center unobtrusively moved across Nova Scotia on the 12th and swung northward. On the 13th, it exploded, plummeting from a 987–hPa reading at 1200 on the 12th to 962hPa in just 24 hr. So at 1200 on the 13th, there was a 968–hPa center in the northern Gulf of St Lawrence and a 962–hPa center some 400 mi (740 km) to the east northeast. Something had to give. They finally merged into a rather paltry, single 976–hPa center on the 14th. This in turn was absorbed by the Bahama Low the following day.

Over the southeastern U.S., a large 1035–hPa High had settled in and extended well out to sea. It

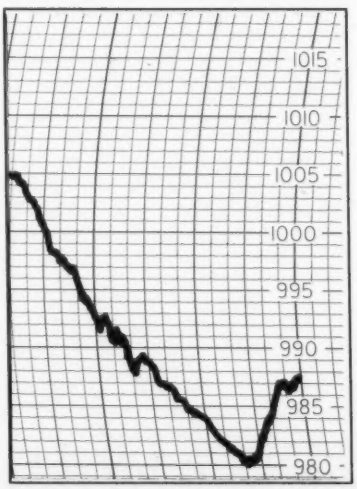


Figure 8.— The Newark Bay was running from Charleston, SC to Rotterdam when she hit storm no. 1 on the 8th.

was flanked by a large 1037–hPa High off Africa. This pattern persisted for several days as the Bahama Low made its way across the Greenland Sea. On the 18th, a small Low formed off the Outer Banks. Moving northeastward, it organized and deepened enough to generate some gale force winds along the New England coast and the Maritimes . However, the system fizzled on the 21st.

3 This short–lived but potent system was first sighted south of Kap Farvel, Greenland, on the 21st sporting a weak 999–hPa center. Within 24 hr, it was a raging storm south of Iceland with a 969–hPa center. Vessels were reporting winds in the 40–to 50–kn (73–93 km/h) range along the shipping lanes. At 2100 on the 22d, the ***Laxfoss*** ran across 52–kn (96 km/h) southerlies near 60°N, 11°W. By this time, the storm was turning southward and heading for Iceland. It continued to generate gales and storm force winds on the 23d. The ***Cumulus*** (57°N, 20°W) had a day of winds that ranged from 45 to 55 kn (83–102 km/h), while battling 18–ft (5 m) swells. The British OSV's problems continued into the 24th, when the system began to fill as it headed toward France.

Several smaller Lows and a large Bermuda High dominated the weather scene over the next several days. The month came to a close with a 972–hPa system in the Davis St but, in general, weather was quiet. A 994–hPa system northwest of the Canary Is was generating some gale force winds within 600 mi (1110 km) of its center.

Casualties and Damage

On the 1st, the Savannah River remained at 11.2 ft (3.4 m), which is just above flood stage at Clyo, GA. The river flooded access roads and low–lying recreational areas. On the 4th, south and southeast gales combined with an unusually high astronomical tide to produce significant flooding along the south facing coasts of Massachusetts. Tides ran 2 to 3 ft (.6–.9 m) above normal. Waves eroded an average of 4 ft (1.2 m) of land along the Cape Cod National Seashore beaches. Peak gusts reached 50 kn (93 km/h) at Chatham. A 100–ft (305 m) section of seawall collapsed in Marblehead. On the 11th, gales in the wake of an intense Low in Canada (See Storm No. 2) caused widespread power outages and property damage across New England. In Bristol, CT, a 62–kn (115 km/h) gust was observed. At Blue Hill Observatory in Milton (elevation 635 ft [194 m]) peak gusts to near 60 kn (111 km/h) were recorded on the 10th, 11th and 12th. In Portland, ME, 4.7 in (119.4 mm) of rain were reported and the Presumscot River in Westbrook crested at 16 in (406 mm) above flood stage. In Portland 5 ft (1.5 m) of water was reported in some of the streets. Block Is, RI, recorded gusts to 74 kn (137 km/h) on the 11th. In Vermont rain changed over to heavy, wet, damaging snow, which accumulated in excess of 30 in (762 mm) in Orleans County.

On the 25th, winds, which gusted to 45 kn (83 km/h) in Montpelier, VT, created waves up to 16 ft (5 m) on Lake Champlain. Four duck hunters had to be rescued by a Coast Guard helicopter when their 14–ft (4.3 m) boat was overwhelmed on the 31st as the cold front produced gusts of 40 to 68 kn (74–126 km/h) over Massachusetts. At Logan International Airport the wind spun a large jet into a wall, while in Worcester an 800–pound (360 kg) prefabricated panel was blown from the 15th floor of a 24–story building.

December— Usually a quick look at the climatic chart can show you where the action was for the month. December's chart (fig 9), however, requires a little study. A 1022–hPa Azores High resulted in positive anomalies of up to 10 hPa over the northeastern North Atlantic, but the weather was not quite so accommodating. The tip–off is the intense 994–hPa Icelandic Low, which extends from near Greenland to the Barents Sea. Negative anomalies of up to –12 hPa were created, indicating intense storm activity in the Greenland and Norwegian Seas.

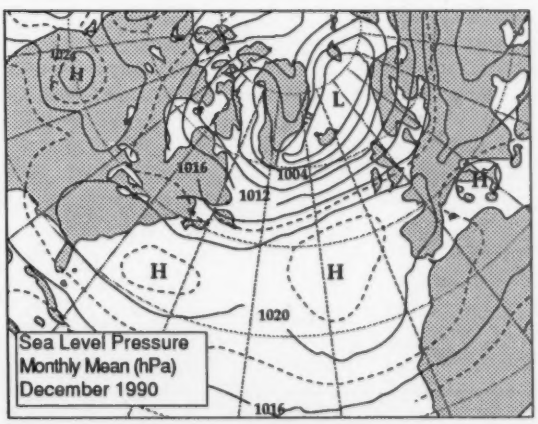


Figure 9.— Check out the intense 994–hPa Icelandic Low, which extends from near Greenland to the Barents Sea. This is the tip–off as to the kind of month that faced mariners plying the North Atlantic trade routes in December. The analysis was provided by John Kopman and Vernon Kousky.

U.S. Coast Guard

Figure 10.— The Argo Merchant breaks up on Nantucket Shoals, resulting in a major oil spill, in December of 1976. Within 4 days after the grounding, a storm from the coast of Georgia took its toll and more than 1.5 million gallons of oil had spilled.

The steering patterns aloft were oriented generally toward the east northeast, but ran northeastward from Newfoundland northward.

On This Date

December 15, 1976— The *Argo Merchant*, carrying 182,600 barrels of fuel oil, ran aground on Nantucket Shoals. It broke in two on the 21st after being pounded by 50–kn (93 m) winds and 20–ft (6 m) seas (fig 10).

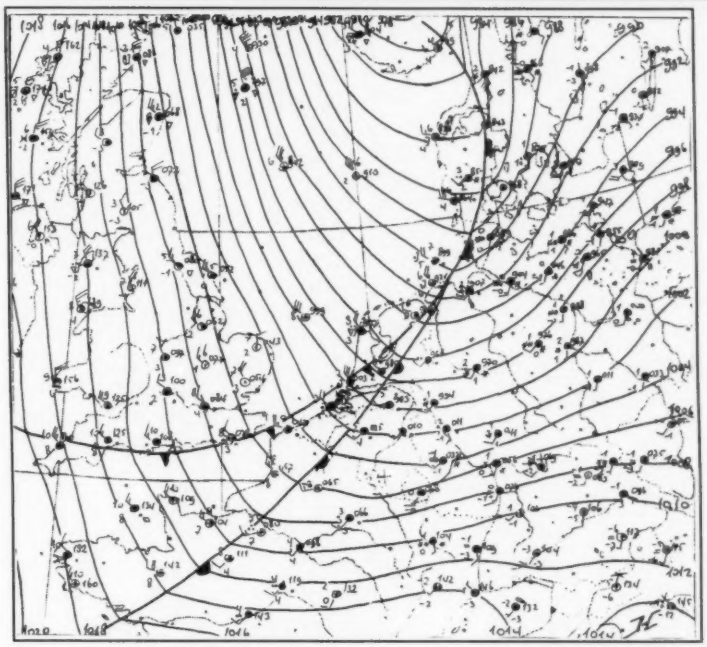
Ocean Weather

A 1032–hPa High off the U.S. East Coast and a 1037–hPa High over England greeted most North Atlantic mariners to start December. A couple of Lows were also on the charts, with the most active being a double–centered system that stretched through the Denmark St and into the Greenland Sea. The tight gradient between it and the English High generated gales southeast of Iceland. Among the vessels affected were the VRGW, UQWZ and LDWR.

Along the frontal system of this Low another small but potent Low was creating some difficulty for the CGDV. Near 44°N, 52°W, they battled 45–to 50–kn (83–93 km/h) winds from 1800 on the lst through 1200 on the 2d; swells were running 12 to 20 ft (4–6 m). Conditions in both areas began to ease on the 3d.

While several moderate Lows roamed the North Atlantic, most of the weather was controlled by a series of intense high pressure systems, which were reinforcing the climatic picture for December. This situation was typical through the middle of the month, with one notable exception.

1 On the 6th, a 970–hPa Low northeast of Iceland was moving toward the east northeast. It trailed a cold front southwestward. Winds along the front were in the 20–kn (37 km/h) range. The Low deepened to 956 hPa as it moved past the North Cape early on the 7th. Its cold front swept across the northern North Sea and Scotland. Winds were generally 20 to 25 kn (37–47 km/h), although a few reports showed 40–kn (74 km/h) winds. At about 70°N, the LNXH (31°E) hit 44–kn (81 km/h) winds with a 968–hPa pressure while the *Apatit* (23°E) had a 961–hPa reading with 43–kn (80 km/h) winds. Even at 0600, one vessel (61°N, 0°) reported a 40–kn (74 km/h) west southwesterly. Things began to



Evert van Veldhuizen

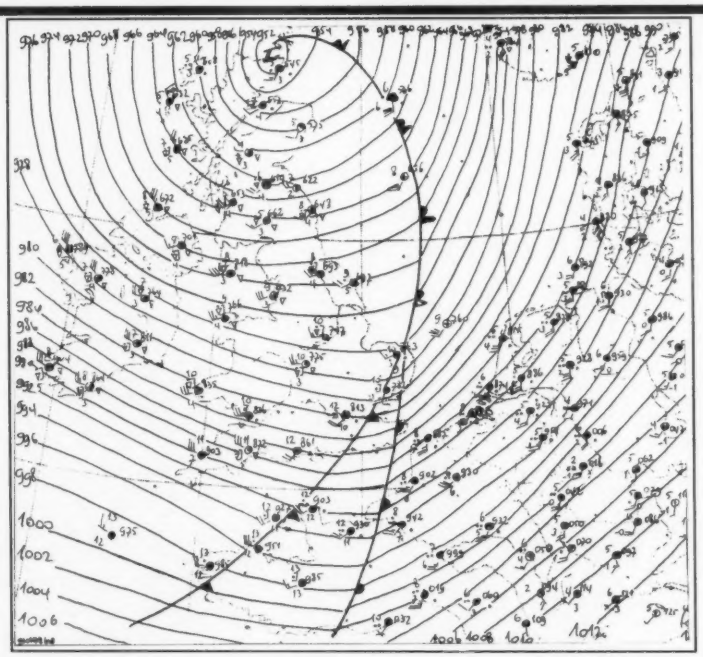
Figure 11.— This surface weather chart prepared at 0400 on the 12th was provided by the Werkgroep Weeramateurs from the Netherlands.

pick up at 1200 on the 7th. Several ships just north of Scotland and near Shetland Is reported 45–to 50–kn (83–93 km/h) winds from a northerly direction with air temperatures at the freezing mark. Seas were running 20 to 25 ft (6–8 m). These ships included the ***Isnes*** and ***Vigilant***. A 1003–hPa center was analyzed over the Irish Sea. By 1800 most vessels in the North Sea were encountering 40–to 50–kn (74–93 km/h) winds. By 1000 on the 8th, the Irish Sea Low was the dominant circulation and was centered northeast of London. In addition, an atmospheric wave was developing along the frontal system over northeastern Spain. To the west, an intense 1040–hPa High was creating a tight pressure gradient.

Snow was falling over a good portion of the area and, with the strong winds, was causing visibility problems at sea and blizzard conditions over a good portion of England and Wales. Conditions were particularly rough in the North Sea. By 1200 on the 9th, the Irish Sea Center was over France with a second center in the Mediterranean Sea. Ships in the eastern Atlantic and North Sea were reporting 40–to 50–kn (74–93 km/h) winds. While this Low gradually weakened over Italy, a system that had set in the Denmark St for several days made a dash east southeastward on the 11th. As this 975–hPa Low moved into Norway, a strong cold front whipped across England and the North Sea with 10– to 20– ft (3–6 m) seas.

However, it was on the 12th that things exploded (fig 11). To blame was the strong pressure gradient between the 975–hPa Low over Norway and the large 1038–hPa High over the Azores. From the Mediterranean to the Norwegian Sea, ship reports flooded in with observations of 40– to 70–kn (74–130 km/h) winds in seas that ranged from 15 to 40 ft (5–12 m). The northern North Sea was hardest hit. The ***GRO Viking*** (60°N, 2°E) and the ***Toisa Sentinel*** (62°N, 10E) both were hit by 70–kn (130 km/h) northwesterlies. The ***Toisa Sentinel*** also estimated seas at 39 ft (12 m). These were no flukes either. At 0600 the GBXW (58°N, 1°E) ran into a 70–kn (130 km/h) northwesterly in 38–ft (12 m) swells; by this time the LNOQ had already registered 75–kn (139 km/h) winds in 30–ft (9 m) seas. Conditions were brutal (see casualty and damage section). Between 0900 and 1200, 10 vessels reported winds of 60 kn (111 km/h) or more, mostly in the northern North Sea, where seas of 25 to 35 ft (8–11 m) were common. Some of the reporting vessels included the ***Yemelyan Pugachev, Seaboard Invincible, Grundarfoss*** and ***Shetland Service***, as well as several drilling rigs. In the Agean Sea at 1200, the ULRS ran into 58–kn (107 km/h) northerlies. Conditions finally eased on the 13th as the High took control. However, the Low was still creating some headaches in the Mediterranean.

During this period, weather was relatively quiet over the Western North Atlantic. However, on the 12th, a storm in the Davis St did intensify briefly to 968 hPa. Its circulation was responsible for some 30–to 40–kn (56–74 km/h) winds over the northwestern North Atlantic. Two Highs held most of the ocean in their grip during the mid part of the month, with most of the cyclonic activity forced into the Davis St and northern Greenland Sea. There was also some extratropical action between the Canary and Cape Verde Is.



Evert van Veldhuizen

Figure 12.— Here is the picture the day after Christmas, and it isn't a pretty sight. This weather chart was plotted for the 1600 UTC data on the 26th by the Werkgroep Weeramateurs of the Netherlands.

2 Monster of the Month—things began to deteriorate on the 21st. A Low that had developed over Lake Huron on the 18th, swept up the St Lawrence Seaway and out to sea on the 20th. By 1200 on the 20th, it was a 981–hPa Low off Kap Farvel, Greenland. Its cold front stretched back to Florida and it was being preceded by a Low over the North Sea. By 0000 on the 21st, central pressure had dipped to 960 hPa and 12 hr later it was down to 950 hPa. At 0000 on the 23d, a 944–hPa center was analyzed just southwest of Iceland and a 950–hPa center off northeast Greenland. The circulation of this huge storm blanketed the Baltic Sea with gales. West winds of 65 kn (120 km/h) were reported by the ***OOCL Assurance*** in 43–ft (13 m) swells near 50°N, 32°W, or some 600 mi (1110 km) south of the storm center. In general, winds were blowing from 40 to 50 kn (74–93 km/h) within the circulation. At 1800, the GBXW hit a 60–kn blow near 58°N, 1°E.

A complex situation was about to become more complicated. On the 23d, a wave formed along a front over northern Alabama. It moved rapidly northeastward across southern New England, Nova Scotia and Newfoundland, intensifying all the while. By 1200 on the 25th, it was a 968–hPa Low heading east northeastward and trailing the Denmark St center, which had finally begun to move toward the east.

The double–centered Denmark St storm had merged into an extremely potent 937–hPa monster. From the Grand Banks to the English Channel, a vessel stood an excellent chance of encountering gales and a very good chance of hitting storm force winds. Seas were running 15 to 30 ft (5–9 m). Christmas was no holiday over the North Atlantic shipping lanes– lucky Santa doesn't come by boat.

Just how intense and extensive was this situation? At 0600 on the 25th, the ***Vytegra*** battled 64–kn (118 km/h) southwesterlies in 20–ft (6 m) seas in the English Channel, while the 3EMF4 ran into 60–kn (111 km/h) west northwest winds some 400 mi (740 km) to the west. At 41°N, 24°W, the SQME reported 52–kn (96 km/h) westerlies, while the DHZD some 1800 (3330 km) mi to the west enjoyed 40–kn (74 km/h) westerlies and frolicked in 26–ft (8 m) seas. The North Sea was not a pleasant sight either. At 1200 the GBXW reported 69–kn (128 km/h) southeasterlies in 33–ft (10 m) swells. Nearby (59°N, 0°) the OVYA was suffering through a 68–kn (126 km/h) south southeasterly, while estimating swells at 36 ft (11 m). The EQQY (60°N, 2°E) in 44–ft (13 m)seas was belted by 65–kn (120 km/h) south southeast winds.

The Denmark St center turned northward on the 25th, and its pressure dipped to 934 hPa by 1200 the following day. Meanwhile the Alabama Low moved over northern Scotland and was analyzed by the Dutch Amateur Work group (fig12). The central pressure in this storm was about 952 hPa. At 1800 on the 26th, the

GRHJ (57.5°N, 0.5°E) recorded a 958.5–hPa pressure and the LFSR (58°N, 1.9°E), at 1500, had a reading of 959.6 hPa. To add a little interest to a situation that was fast getting old, another center entered the system on the 28th. This one developed west of Kap Farvel, on the preceding day, and moved east northeastward while intensifying. By 1200 on the 28th it was down to 950 hPa. This extended the area of strong winds from the Grand Banks to the North Sea. Highest seas were in the 25–to 35– ft (7-11 m) range. It wasn't until the last day of the month that conditions began to ease over the shipping lanes.

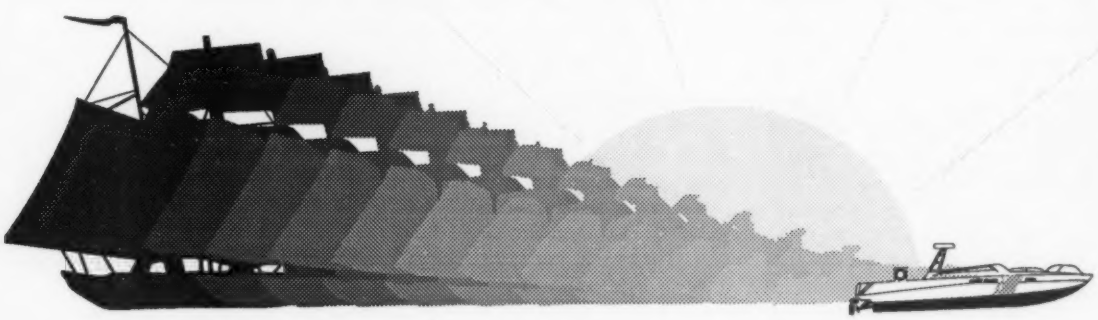
Casualties and Damage

Space prevents a complete summary of all the problems to shipping in December, but included are some highlights.

On the 10th the Mv ***Herceg Novi*** suffered heavy weather damage due to shifting cargo after leaving Fexlixtowe. During the snow storm of the 8th and 9th in England and Wales, eight people died. Snow drifted up to 12 ft (3.7 m) high leaving motorists snow–bound. The ***Candourity*** was driven aground but refloated during the storm. Wind, rain and snow also battered Italy and France. The wind–whipped sea rose 3 ft (0.9 m) above normal, flooding one–half of Venice. The Mvf ***Premier*** capsized off the Shetlands in winds that gusted to force 10 and reported 60–ft (18 m) waves. The six fisherman were lost. The ***Maersk Vinlander*** slipped tow in gales in the northern North Sea, with 56 crewmen aboard; all were reported safe. It was also reported that the self propelled semisubmersible drilling platform ***Glomar Arctic III*** (61.7°N, 0.8°E), with 73 on board, was hit by a freak wave and two lifeboats were washed overboard. There were some slight injuries, and as a precaution 37 non–essential crewmen were airlifted off. The ***Lingens*** was driven aground on the 11th near ***Kvitsoy*** but refloated. The three–man crew aboard radio station vessel ***Ross Revenge*** were airlifted to safety on the night of the 10th as the vessel was battered by severe gales 15 mi (28 km) east of North Foreland Lighthouse. On the 8th, the fishing vessel ***Golden Hope*** sank in Holyhead harbor in strong northerly winds. Nine Italian cave explorers were found on the 11th after being buried by several feet of snow in an avalanche related to this storm of the 8th/9th.

On the 28th, in rough seas the Israeli ferry ***Al–Tuvia*** capsized in the Bay of Haifa with loss of 21 lives of U.S. sailors returning to the ***Saratoga***.

At least nine people were feared dead in the severe weather that struck Northern Europe and Scandinavia during the last week of December. On the night of the 27th, south of Finland, a Norwegian coaster and Finnish tug capsized with the loss of seven crewmen and a pilot. Two crewmen were rescued after spending almost 9 hr in an air pocket. The Master of the 644–ton ***Jarita***, which sank about 20 mi (37 km) off the Kent coast, died in hospital suffering from exposure after spending nearly 5 hr in the water. Thirteen crewmen from the ro–ro ship ***Maersk Yare*** were rescued after she was driven aground at Scheveningen in gales.



U.S. Coast Guard

North Pacific Weather October, November and December 1990

October— This month the Aleutian Low could be called the Gulf of Alaska Low, even though it's in an average position, but a little deeper than normal (fig 1). There is also a secondary center in the Sea of Okhotsk. The subtropical high is a little stronger than normal. In the steering levels the flow is fairly zonal, so that in an ideal situation a storm would track from Tokyo to San Francisco.

On This Date

October 16, 1966— A Pan American Stratocruiser was forced to ditch midway between San Francisco and Honolulu when two of her engines failed (fig 2). The U.S. Coast Guard Cutter *Pontchartrain* was on weather patrol as *OSV N* and quickly came to the rescue. Within 20 min, the 24 passengers and 7 crew members were safely aboard the cutter. The plane sank 1 min later.

Ocean Weather

The month opened with tropical cyclones Rachel, Odile and Polo in the eastern North Pacific and Tropical Storm Hattie in the west. (The eastern North Pacific season is reviewed on pg 24).

Hattie developed some 240 mi (444 km) east of Guam. It became a tropical storm on the 2d and a typhoon on the 5th, some 70 mi (130 km) south southeast of Okinawa. It crossed the south coast of Honshu on the 8th and, by that time, was down to tropical storm strength. While Hattie was intensifying, Ira formed in the South China Sea some 300 mi (555 km) southeast of Danang on the 2d. It weakened and moved across Thailand, bringing heavy ran and severe flooding.

Over the open Pacific to the northeast, a small Low was flanked by two tremendous Highs. On the 3d, a 978–hPa Low showed up in the Sea of Okhotsk, but there were no ship reports of strong winds or high seas. This run of relatively good shipping weather continued for several days, with the exception of Typhoon Hattie.

Another Low meandered through the Sea of Okhotsk for several days contributing to that climatic center. This storm and its trailing, slow–moving cold front generated some gale force winds east of the Kuril Islands on the 8th and 9th.

A system developed along the front, as it moved slowly eastward and then headed northeastward into the Gulf of Alaska. On the 11th, it was a 977–hPa Low with an active cold front, which stretched southwestward. This

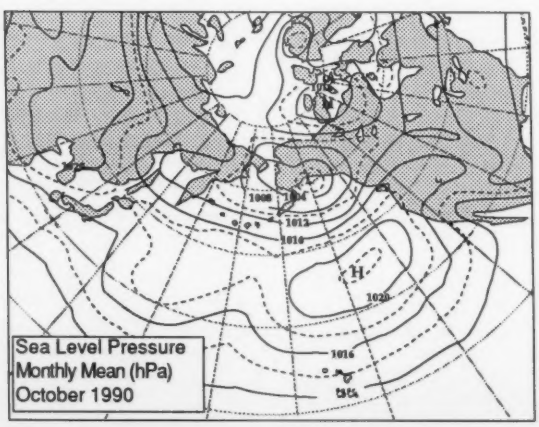


Figure 1.— The Aleutian Low covers the Gulf of Alaska, which is not even that unusual, as many Pacific mariners could tell you. This analysis is brought to you by John Kopman and Vernon Kousky.

U.S. Coast Guard

Figure 2.— Sovereign of the Skies was the name of the stratocruiser that is seen in the water. The plane was on a routine flight from Honolulu to San Francisco when two engines failed. Luckily this was in the days of the OSV program and all were saved.

activity was witnessed by the ***President Harrison*** and the 6ZLH, both of which encountered 40–kn (74 km/h) winds southwest of the center. Seas were running 10 to 15 ft (3–5 m). The 973–hPa center moved inland near Juneau on the 12th. The circulation, however, stretched from the Aleutians to Vancouver Is, and this long fetch was responsible for some 20–to 23–ft (6–7 m) swells in the eastern part of the area.

Two large Highs covered a good portion of the Pacific south of the Aleutians for the next few days. Kyle came to life 300 mi (555 km) east of Guam on the 15th. It reached typhoon strength some 500 mi (925 km) to the north northwest of Guam on the 20th, as it began to recurve. The system accelerated toward the northeast and weakened as it passed about 700 mi (1300 km) east of Tokyo on the 22d. While Kyle was forming, an extratropical system was developing over the Sea of Okhotsk and another near 35°N, 175°E.

1 This central Pacific system had to battle its way between the two Highs as it moved northeastward. It was not an impressive looking system until the 17th, when it crossed the 50th parallel near 145°W. It then became very impressive to the ***Jade Forest*** (50°N, 145°W) which ran into 47–kn (87 km/h) west northwest winds and a 981–hPa pressure at 0000. At 1200, the UYEV was clobbered by 54–kn (100 km/h) west southwesterlies, and just 3 hr earlier the KNJB in storm force winds battled 20–ft (6 m) swells (fig 3). At 0000 on the 18th, central pressure was estimated at 960 hPa, shortly before the center moved inland near the Queen Charlotte Is. Ships were reporting 40–to 45–kn (74-83 km/h) winds at this time. Meanwhile, to the northwest another storm was reaching its peak.

2 This storm was spotted in the Sea of Okhotsk on the 15th. Moving east northeastward, it developed rapidly once east of the Kamchatka Peninsula. By 1200 on the 17th, its central pressure was down to 977 hPa. Some 24 hrs later it fell to 968 hPa.

Storm force winds were being reported by a few vessels on the 17th, including UHNM (57°N, 166°E) with a 58–kn (107 km/h) blow, but reports really flooded in on the 18th. Some of the reporting vessels included the ***Petr Ovchinnikov, Stepan Krasheninnikov, Igarka, Westwood Annette,*** and the ***Prostor.*** The storm began to fill the following day.

While these two storms

Figure 3.— The Low from the Sea of Okhotsk approaches the Queen Charlotte Is on the 17th, while a strong cold front trails across the Pacific Northwest and then toward the southwest. The hot region was from about 50° to 60° N between 150°E and 170°E. Winds were mainly in the 40- to 50- kn (74-93 km/h) range, but a few exceeded that. Seas topped out at about 15 ft (5 m).

were creating havoc in the northern waters, Lola flared briefly over the South China Sea on the 17th. It formed about 325 mi (600 km) east southeast of Danang and by the 18th it was over the coast of Vietnam as a tropical storm. It weakened as it moved inland but torrential rains caused extensive flooding.

During the third week in October tropical waters were dominated by typhoon Kyle in the west and hurricane Trudy in the east. On the 23d, a 973-hPa Low was centered in the Gulf of Alaska and its circulation covered a good portion of the Bering Sea and northeastern North Pacific. The ***Suruga Maru*** and XWNDM (near 51°N, 132°W) hit winds at 43 to 48 kn (80–89 km/h) at 1800. The ***Japan Alliance*** reported 60-kn (111 km/h) west northwesterlies near 53°N, 155°W at 0000 and 0600 on the 24th, so this was a potent 2-day storm. Also during this period the extratropical remnants of Kyle were generating 40-to 45-kn (74–83 km/h) winds near 35°N, 135°E. On the 25th, several reports of storm force winds were received from near its center, which was crossing the 35th parallel near 150°E. However, it was filling.

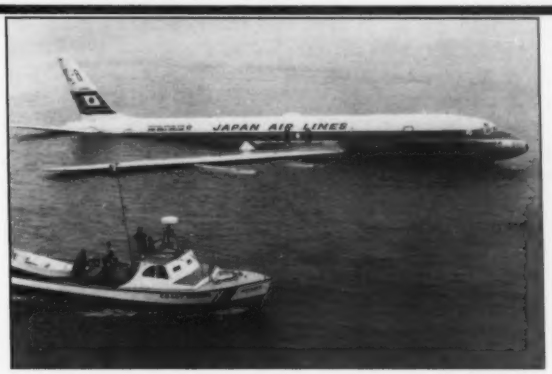
A wicked storm brought the month to a close. This system came to life on the 25th as a weak frontal wave near 45°N, 175°W. Things got organized the following day as it moved eastward. Then it turned northward and exploded. By 1200 on the 26th, central pressure dropped to 973 hPa and to near 952 hPa by 0000 on the 27th as it neared the 55th parallel to begin a counter clockwise loop. Its impact on shipping began at 1800 on the 26th when half a dozen vessels reported winds in 40–to 60–kn (73–111 km/h) range with seas of 10 to 15 ft (3–5 m). At 0000 on the 27th, the ***Kenai*** (52°N, 137°W) reported a 969–hPa pressure while battling 52–kn (96 km/h) southerlies in swells estimated near 40 ft (12 m). Several other vessels in the vicinity reported 40–to 45–kn (74–83 km/h) winds. The XELKQ7 registered a 965–hPa pressure near 55°N, 138°W, and, at 0600, her pressure fell to 952.5 hPa near 55°N, 140°W. She was also reporting 40–kn (74 km/h) southerlies in 28–ft (9 m) seas, while nearby the ***Sansinena*** had a 958–hPa reading in 43–ft (13 m) seas. By 1200 the ***Sansinena*** was running into 64–kn (118 km/h) southerlies in 34–ft (10 m) seas with a 968–hPa pressure. This was an intense storm. Conditions eased on the 28th as the Low began to fill. The following day its central pressure had risen to 1004 hPa.

However, the month did not end quietly as a system formed quickly in the wake of this storm, on the 29th. Its pressure fell to 972 hPa by 1200 and was down to 968 hPa by 0000 on the 30th as it headed inland near the Queen Charlotte Is.

Casualties

Heavy rains from Typhoon Hattie triggered 68 landslides in Japan, resulting in three deaths and one missing person. Rains from Ira over Vietnam caused flooding, which was responsible for six deaths and another four missing people. Finally Lola was blamed for 23 deaths in Vietnam, mostly drowning.

November— About this time of the year, the Aleutian Low begins to dominate the climatic charts as extratropical storms move along the Aleutians and into the Gulf of Alaska. This November it was replaced by what can only be termed the Aleutian High (fig 4). As incredible as it seems, a 1026–hPa High was just south of the Aleutians generating positive anomalies of up to 24 hPa.



U.S. Coast Guard

Figure 5. — The Japan Air Lines DC–8 jet from Tokyo rests serenely in the waters off San Francisco International Airport. Thanks to the U.S. Coast Guard 108 people were removed to safety in boats and liferafts.

This forced the Aleutian Low to split into two centers— one in the Sea of Okhotsk and one in the Gulf of Alaska. The steering pattern at 500 hPa was nearly zonal with a slight ridging, which reflected surface conditions, around the International Dateline. This would take a storm, in an ideal situation, from Tokyo to San Francisco.

On This Date

November 24, 1968— A Japan Air Lines DC–8 from Tokyo crashed in fog–bound waters off San Francisco (fig 5). The Coast Guard helped rescue the 108 passengers and crew members.

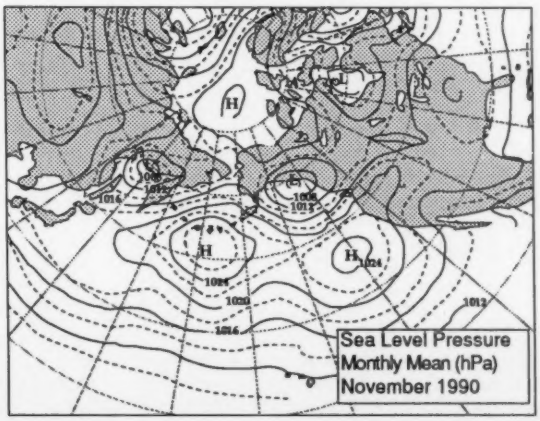


Figure 4.— Just south of the Aleutians is a subtropical high, where the Aleutian Low normally hangs out. Analysis was provided by John Kopman and Vernon Kousky.

Ocean Weather

The track chart for November illustrates exactly what shows up on the climatic chart. There is a concentration of low pressure systems in both the Sea of Okhotsk and Gulf of Alaska, while a big hole exists across the central North Pacific. A track chart of high pressure systems shows concentrated activity west of California and in the central North Pacific, where several Highs attained a central pressure above 1040 hPa.

The month opened with the remnants of Typhoon Trudy roaming the eastern North Pacific and a 992–hPa Low generating a few gales east of Tokyo. Neither remained on the scene for long. However, over western waters activity was brisk as several small Lows and an inverted trough of low pressure, along with an intense wedge of high pressure, resulted in gale force winds and rough seas west of 180° between 30°N and 50°N. These conditions were evident on the 4th and 5th. For example, the ***Liverpool Bay*** (32°N, 136°E) ran into 40–kn (74 km/h) winds in 10–ft (3 m) seas at 0000 on the 4th, while the ***President Harrison*** was belted by 47–kn (87 km/h) northwesterlies 12 hr later near 47°N, 167°E. At 0000 on the 5th, the

Uglekamensk (45°N, 147°E) was clobbered by a 52–kn (96 km/h) easterly, which was confirmed by the ***Kuznetsk*** nearby. Storm force winds were also reported at 0600 by the UBKN and ***Babayevsk*** in the same vicinity; by this time the ***Uglakamensk*** measured winds up to 56 kn (104 km/h). This activity was associated with a 990–hPa Low, which developed in the Sea of Japan and headed northeastward. The intensity was enhanced by the 1038–hPa High over the Kamchatka Peninsula, which squeezed the pressure gradient. Conditions eased somewhat on the 6th, although at 0000 the ***Polar Alaska*** (47°N, 153°E) ran into 48–kn (89 km/h) east southeasterlies in 10–ft (3 m) seas.

On the 7th, a tropical depression developed some 500 mi east southeast of Yap, and headed toward the west northwest. It crossed Hainan on the 17th and moved over northern Vietnam as a tropical depression.

While Mike was approaching Koror, Nell developed over the South China Sea on the 10th. It reached tropical storm strength the following day and made landfall over southern Vietnam about 200 mi (370 km) northeast of Ho Chi Minh City on the 12th.

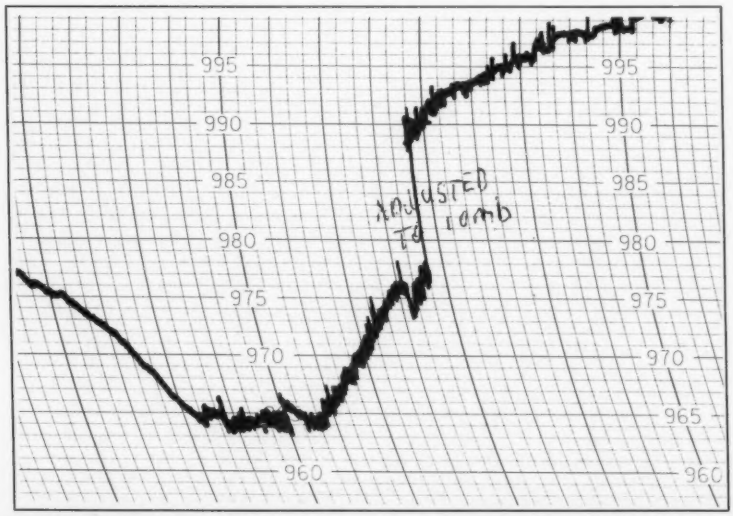
In the eastern North Pacific during the second week in November, a Low well north of the Hawaiian Is was generating some gale force winds as it bumped up against the large 1040–hPa High east of Kamchatka. A 1030–hPa High covered the seas between California and Hawaii, while a 990–hPa Low had moved into the Gulf of Alaska.

1 The storm north of Hawaii actually developed on the 5th near Midway Is. The following day it merged with a system from the west. Shipping was well aware of this storm. At 1800 the LMW03 (36°N, 171°W) radioed a report of 50–kn (93 km/h) south southwesterlies, which provided some input as to the intensity of this system. At 0600 on the 7th, the ***President F. D. Roosevelt*** (32°N, 171°W) battled 12–ft (4 m) seas in 42–kn (78 km/h) west northwesterlies. The system was heading northwestward, but the following 2 days jogged eastward, southwestward and then eastward. During this period, it wasn't much of a storm, however, the gradient between it and the 1046–hPa High kept winds in the 30–to 40–kn (56–74 km/h) range through the 11th.

The storm was then heading northeastward. By the 12th, as it crossed the 50th parallel near 138°W, pressure fell to 968 hPa and another 8 hPa during the next 12 hr (fig 6). At 1200 on the 12th, the ***Sanyo Maru*** (50°N, 135°W) encountered 55–kn (102 km/h) southwest winds and measured 60–kn (111 km/h) winds near 46°N, 135°W; she was battling 21–ft (6 m) swells. This was confirmed by Buoy 46004 (51°N, 36°W), which reported 60–kn (111 km/h) south southwesterlies, 26–ft (8 m) seas, with a 7–sec period and a 969–hPa pressure. The slope of the seas was 1/10, which is steep. The CBIM6 (54°N, 143W) was belted by 50–kn (93 km/h) northerlies in 10–ft (3 m) seas (fig 7). Luckily, during the day on the 13th, the system began to fill rapidly and gale reports dropped off dramatically.

On the 15th, the remnants of the Midway Low merged with another system from the Aleutian Is. This regenerated storm dominated weather over the northeastern North Pacific and Gulf of Alaska on the 15th and 16th, until pushed inland by a mammoth 1044–hPa High, which spread across the entire eastern North Pacific on the 17th. It dominated the weather for several days.

Page developed as a tropical depression, on the 19th, about 300 (555 km) mi south of Guam. It reached tropical strength on the 23d, while heading westward. Page became a typhoon some 850 mi (1573 km) east of Manila on the 25th, but turned toward the north-



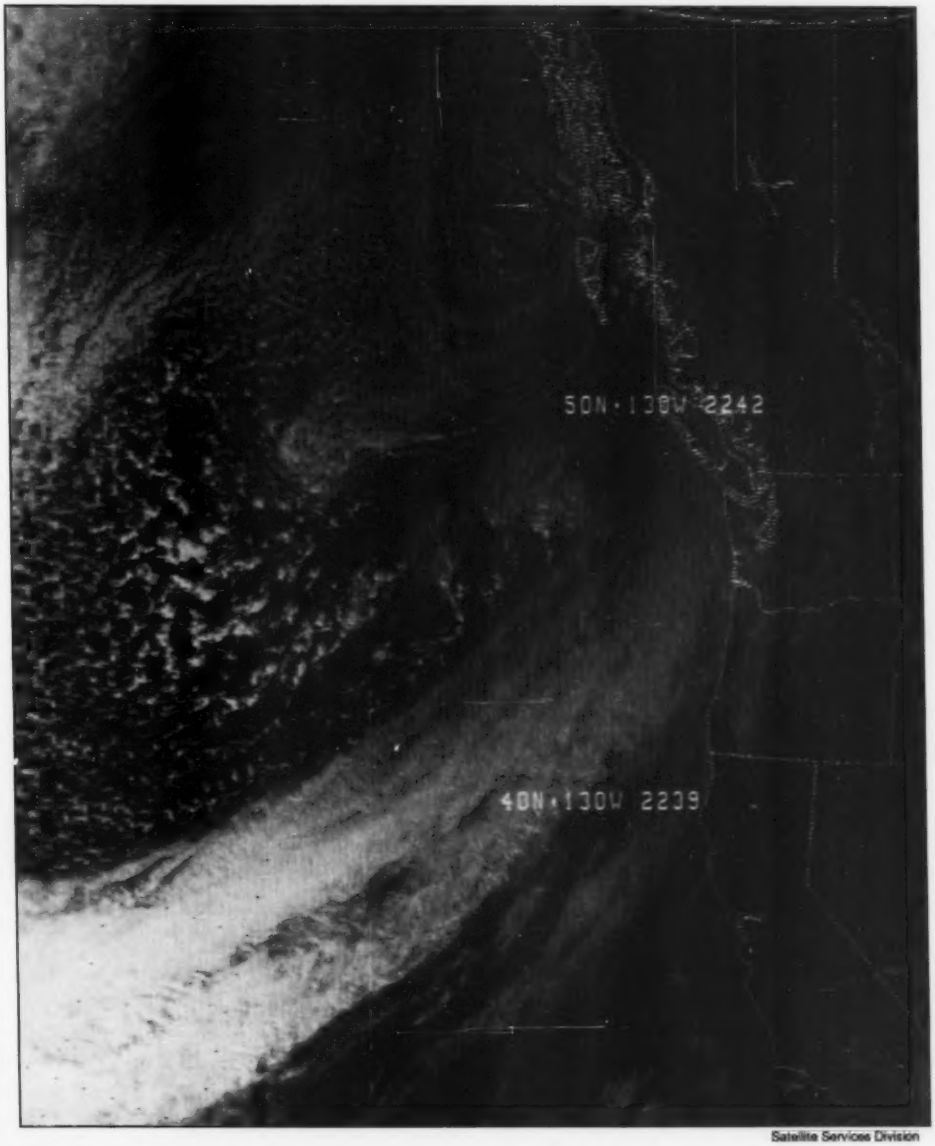
*The **Maersk Pine** reported force 11 winds at 1200 on the 12th and her barometer dipped to 973 hPa (adjusted) near 49°N, 136°W.*

The Barogram had to be adjusted by 10 mb on the 12th. The vessel was enroute from Hiroshima to the West Coast of the U.S.

westward the following day, and recurved north northeastward on the 28th. By the end of the month, tropical storm Page had moved across Honshu.

While Page was coming to life, on the 19th, the High over the eastern North Pacific built to 1048 hPa. It began to weaken by the 21st, but was flanked by a 1048–hPa High in the west. A Low, moving along its western side, deepened to 964 hPa by the 21st in the Sea of Okhotsk. It generated strong winds in the surrounding waters. About this time, Owen was a tropical depression over the Marshall Is. Moving westward, it intensified and became a typhoon by the 22d, some 580 mi (1073 km) south southwest of Guam. The typhoon meandered west southwestward for several days, then picked up speed and, by the 30th, made an abrupt turn to the northeast before weakening.

On the 25th, while Owen and Page were dominating the trop-



Satellite Services Division

Figure 7.—Late on the 12th, the center of this system was located off the Queen Charlotte Is and creating problems over eastern British Columbia and the northwestern U.S. Its frontal system was causing some real problems to the ships plying these waters. This was just one of a number of systems to affect this region in November and December.

ics and several high pressure centers covered the mid latitudes, a Bering Sea storm intensified briefly off Cape Romanzof, AK. At 1200 the central pressure was estimated at 970 hPa and several vessels were picking up 40–kn (74 km/h) winds. At 0000 on the 26th, the H8DZG (54°N, 166°W) came in with 50–kn (93 km/h) westerlies. The storm swung across southern Alaska and filled on the 26th. The month was ushered out by Tropical Storm Page over Honshu and Typhoon Owen in the Caroline Is.

Casualties and Damage

Typhoon Mike was responsible for most of the casualties and damage in the Pacific in November. In the Philippines 560 people were dead or missing, while a total of 64 ships were sunk. Many more vessels were driven aground. Some of the ones that sank or were capsized at Cebu include: ***Trans Asia, Ramon Aboitiz, Florante, Asia Brune I, Charlene, Aleson, Aleson II, Sweet Home, Eduardo Antonio, Don Beatriz, Don Victoriano, Vincent, Lady Janet*** and a host of others.

On the 29th in the Bering Sea, the ***Tide*** was in contact with both the ***Bering Hai*** and fish factory ***Yun Hai*** in heavy seas.

The November Floods in Washington State

Bob Jackson and Dana Felton,WSFO Seattle, WA.

There were two major flood events during the month of November in Washington State. The first event occurred on Veteran's day weekend, and the second occurred the week of Thanksgiving.

The first event mainly affected the northernmost counties of western Washington with the heaviest precipitation occurring in northeast Whatcom County and southern British Columbia. Five counties, Whatcom, Skagit, Snohomish, Jefferson and Grays Harbor, were declared disaster areas.

During the second event, there were strong westerly winds aloft which carried some of the precipitation across the Cascade mountain crest, and caused some heavy runoff in three counties of eastern Washington.

The heaviest precipitation amounts during the second event fell in the central Washington Cascades and caused more widespread flooding than the first flooding event of the month. After the second event, another three counties were declared disaster areas

In all, there was flooding at 29 river forecast points on 18 different rivers for which flood forecasts were made. Record floods were recorded at seven NWS flood forecasting points.

The weather pattern that was responsible for the heavy precipitation that caused the floods was nicknamed the *Pineapple Express*. On the days prior to the beginning of the first flooding event, a full latitude ridge existed over the eastern Pacific. Strong winds and a generous supply of tropical moisture were associated with the ridge. Cold air from the Aleutian Island area began to flatten the ridge and depress the flow of moisture into northwestern Washington. A continuous supply of moisture, a high freezing level, and strong winds at all levels perpendicular to the Cascade mountains, caused a very moist orographic flow over the North Cascades and southern British Columbia. Rain began falling Thursday afternoon (11/8/90) and continued through early Sunday.

The ridge lifted northwards in response to a wave forming on the baroclinic zone. This caused a temporary pause in the rainfall Monday morning (11/12/90). The wave formed into a front, which moved across Washington Tuesday morning (11/13/90). Steady rain ahead of the front gave way to showers after the frontal passage. Precipitation amounts were not sufficient enough under normal circumstances to cause flooding, but with the rivers already swollen and the watersheds saturated, an immediate rise in the rivers occurred. The weather pattern for the second flood event of the month was nearly identical to the first one, with the exception being the main core of the jet stream was farther south. This brought the heavier precipitation the west slopes of the central Washington Cascades instead of the northern part of the Cascades, as was the case in the first event.

On the 23d, winds gusted to 60 kn (111 km/h), ripping the roof off a furniture store in Aberdeen, WA. In Bellingham and other areas power outages were common. Waves generated by these winds sank parts of the old Interstate 90 bridge across Lake Washington, in Seattle. Spokane recorded a 49–kn (91 km/h) gust on the 24th. Many locations set rainfall records from the 23d to the 25th. Seattle–Tacoma Airport reported a 24–hr November record of 3.58 in (91 mm) while Olympia registered an all time 24–hr record of 5.82 in (148 mm). By early on the 24th all major rivers north of Seattle were above flood stage. Two men were killed during the flooding; one 52–yr. old man died when he attempted to go kayaking on the Green River, which was flowing at 10 times its normal rate. Thousands of cattle were drowned in western Washington. Total damage for both floods during the month is estimated at $150 to $200 million.

December— The outstanding climatic feature for the month was the Pacific subtropical high, which was stronger than normal and nearly 15° farther north (fig 8). This resulted in positive pressure anomalies over the entire northeastern North Pacific and Bering Sea. They reached +14 hPa near 50°N, 150°W. The Aleutian Low was still an important feature, just farther west than usual. In the steering levels of the upper atmosphere (500 hPa), the general flow was toward the east northeast over western waters, with ridging in the eastern Pacific, which means a northeastward flow bending back toward the southeast near the North American coast.

Figure 9.— Redondo Beach, CA on the 6th of December 1969. Breakers of 12 to 20 ft (4–6 m) were prolduced by heavy swells from a Low in the Gulf of Alaska.

On This Date

December 6, 1969— An intense Low moving into the Gulf of Alaska generated 40–to 50–kn (74–93 km/h) winds south of its center, which produced 35–ft (11 m) seas directed toward the coast of Southern California (fig 9). These seas translated into swells of 8 to 10 ft (2.4–3 m), which resulted in 12–to 20–ft (4–6 m) breakers that hammered away at exposed beaches.

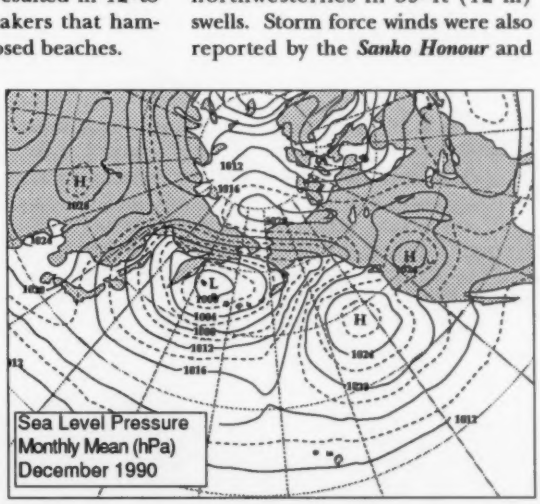


Figure 8.— The Aleutian Low was farther west than normal for December. Storms were forced into a different pattern by the building of the subtropical high. This analysis was provided by John Kopman and Vernon Kousky.

Ocean Weather

As the month opened, Tropical Storm Owen, from November, was heading northward along the 140°E meridian. It was weakening and by the 3d dropped to a tropical depression about 725 mi (1340 km) east of Manila. It dissipated the following day. Several large Highs and small Lows populated the weather charts early, but one of these Lows intensified briefly.

On the 2d, a Low in the eastern Bering Sea flared up and generated 40–to 50– kn (74–93 km/h) winds to the south of its center, where seas were running 12 to 20 ft (4–6 m). At 1800, the ***Yashirokawa Maru*** (52°N, 166°W) encountered 52–kn (96 km/h) west northwesterlies in 39–ft (12 m) swells. Storm force winds were also reported by the ***Sanko Honour*** and the ***Neptune Sheridan***.

Meanwhile, another system had come to life east of Sakhalin Is on the 2d, and made its way into the Bering Sea the following day. By 1200 on the 3d, its central pressure was down to 971 hPa, and it fell to 964 hPa some 24 hr later.

The first storm had crossed the Alaska Peninsula and, as a 976–hPa Low, was recurving northward into the Gulf of Alaska (fig 10). The combination of these two storms made it rough for vessels all along the northern shipping lanes. For example, at 0000 on the 4th the DZUTH (49°N, 128°W) hit 49–kn (91 km/h) southerlies while the ***Sanko Honour*** (40°N, 138°W) fought 44–kn (81 km/h) westerlies. By 0000 on the 5th, the Gulf Low had faded but a double–centered system in the Bering Sea was still causing headaches. The ***Hanjin Kobe*** (45°, 176°W) hit 58–kn (107 km/h) westerlies in 18–ft (5 m) seas, while the ***President Madison*** (49°N, 174°E) reported 55–kn (102 km/h) west northwest winds. Conditions finally eased on the 7th. A trio of Highs along the 30th parallel from the Baja to Shanghai extended their influence north to the Aleutians for a couple of days.

On the 9th, a Low from the Sea of Okhotsk generated some gales in the southern Bering Sea. At 0600, the UVCM reported a 50–kn (93 km/h) westerly near 51°N, 175°E in 20–ft (6 m) seas,

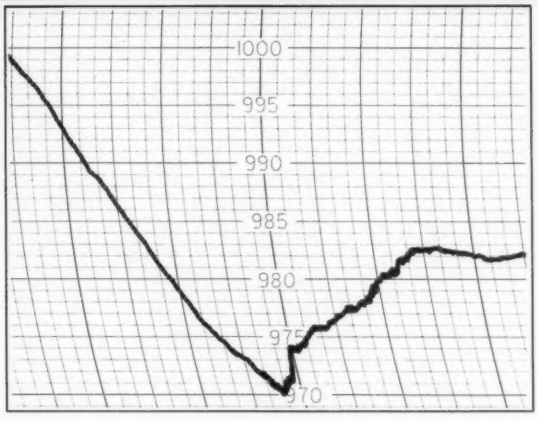


Figure 9.—The Chesapeake Trader was in Valdez when this storm went through. The barograph trace indicates that this was a potent system as it bottomed out at 970 hPa just before 1200 on the 3d.

and this was confirmed by the UJCQ. The ***Nosac Explorer*** (54°N, 176°W) was belted by a west southwest 54–kn (100 km/h) wind in 23–ft (7 m) seas early on the 10th. During the day, several vessels encountered 45–to 50–kn (83–93 km/h) winds, but the storm began to fill. A large double–centered High remained in place over a good part of the eastern North Pacific while western waters were the site of abundant cyclonic activity, none of which was severe until the 13th.

1 The baby came to life just northeast of Tokyo on the 11th. However, until the 13th it was just another of the numerous systems that were popping up and dissipating in the west. By 1200 on the 13th, this northeastward moving Low intensified to 968 hPa as its center crossed the 165°E meridian, near 43°N (fig 10). The ***Yashirokawa Maru*** (44°N, 160°E) helped document its intensity when she reported a 47–kn (87 km/h) northerly at 1200, after encountering 50–kn (93 km/h) just 3 hr before. Luckily, this was about the storm's peak, and as it moved toward the northern shipping lanes, it began to fill. However, the Low remained potent enough to generate 40–to 50–kn (74–93 km/h) winds on the 14th. In fact, at 0600 the ***Fuhwo Venture*** (44°N, 175°E) ran into 53–kn southwesterlies. The storm brushed the Alaska Peninsula on the 15th, but then turned eastward across the Gulf of Alaska as it continued to fill.

In the meantime the tropics were spawning Typhoon Russ. It formed as a tropical depression over the Marshall Is on the 14th and became a tropical storm that night. Moving steadily west northwestward, Russ attained typhoon intensity some 890 mi (1650 km) east southeast of Guam on the 17th. It passed about 50 mi (93 km) south southwest of Guam on the night of the 20th , causing considerable damage. Wind gusts of 100 kn (185 km/h) were reported. Russ gradually turned toward the northwest and began to recurve. It weakened as it passed 70 mi (130 km) southeast of Iwo Jima. By the 25th, it had dissipated. During this period, the eastern North Pacific remained under the influence of high pressure, while several moderate Lows moved through the Gulf of Alaska. In the west, a severe winter storm was spotted off the Kamchatka Peninsula on the 17th.

2 This system was first detected on the 15th as a wave along a cold front southeast of Tokyo. The following day it had a recognizable circulation, but was nothing to write home about. It was moving north-

Satellite Data Services Division

Figure 10.— This was shot early on the 13th southeast of the Kuril Is. As this photo was taken the storm was deepening rapidly and its pressure dropped to 968 hPa by 1200 on the 13th.

eastward and a few vessels southwest of its center caught 30–kn (56 km/h) winds. On the 17th, as Russ became a typhoon, it began to show its colors. At 0000, the central pressure was estimated at 972 hPa; by 1200 it was down to 958 hPa as the storm swung northward. At 0600, the ***Poquita Mami*** (53°N, 173°E) reported 48–kn (89 km/h) southeast winds while the ***Mlechnyy Put*** was battling 23–ft (7 m) seas near 53°N, 150°E. As rapidly as this storm deepened, it filled just as fast. By the 18th, it was a weak 984–hPa center over Siberia.

The blocking eastern North Pacific High was forcing many storms to track into the Gulf of Alaska, bringing a parade of bad weather to the coast, from southeast Alaska to the Pacific Northwest. Because of the tight gradient, some of these Lows generated gale force winds even though they did not look particularly intense. One such storm moved along the 55th parallel and into Canada just north of the Queen Charlotte Is on the 17th. It was a 990–hPa Low. At 0000 on the 17th, the 9VNW reported 40–kn (74 km/h) westerlies near 54°N, 149°W, and coastal stations were reporting 30–to 40–kn (56–74 km/h) winds as the system approached.

In a break from the dominance of high pressure, a large 973–hPa Low was analyzed on the 21st at 1200 near 48°N, 178°E. Its circulation was a good 1800 mi (3330 km) in diameter. The JGNH 900 mi (1665 km) southeast of the center encountered a 40–kn (74 km/h) southerly, while ***Skaugran***, some 650 mi (1200 km) to the south, hit 40–kn (74 km/h) westerlies. The storm moved northward, weakened significantly over the next 2 days, and was replaced by another High. Weather conditions were relatively quiet until the 27th.

3 This storm actually developed northeast of Tokyo on the 26th. It intensified rapidly and by 1200 on the 27th was a 971–hPa storm with a growing circulation. The ***Blue Hawk***, some 650 mi (1203 km) southwest of the center, ran into 43–kn (80 km/h) west northwest winds in 20–ft (6 m) swells. This was confirmed by the JAON, nearby, which was fighting 48–kn (89 km/h) winds from the same direction. Along the associated cold front, a ship reported a 55–kn (102 km/h) south southeasterly. This system continued to intensify as it moved eastward and then northeastward. By 1200 on the 28th, as the center crossed the 45th parallel near 165°E, its pressure dipped to 956 hPa— a real blockbuster. Wind reports reflected this deepening, as more and more vessels encountered storm force winds in 15–to 30–ft (5–9 m) seas, particularly south and southwest of the center. At 1800, the 8NJH ran into a 55–kn (102 km/h) west northwesterly near 40°N, 161°E, while the ***Sea–Land Liberator*** (52°N, 127°E) measured 50–kn (93 km/h) winds from the east southeast. The 28th was the peak time for this large, intense storm. Fortunately, it began to weaken rapidly as it pushed eastward. It was the last significant system of a most unusual month.

Casualties and Damage

Off Everett, WA on the 17th and 18th, the ferry ***Elwha*** sustained contact damage during heavy weather. Typhoon Russ was said to have been the strongest storm to hit Guam in 17 years. According to Capt. Dieter Randolph, Commander Joint Typhoon Warning Center, the typhoon made its closest approach at 4 a.m. LST on Friday the 21st. There were 88 people reported injured and more than 2,000 houses were damaged. A Korean fishing vessel sank south of the island and none of the 10 crewmen on board were found.

A strong arctic front moved through western Washington late on the 18th bringing north to northeast winds, which gusted to over 50 kn (93 km/h) to the Bellingham area. These strong winds reached the northern portion of Puget Sound by early afternoon. A local phenomena known as the Puget Sound Convergence Zone developed and dumped heavy snow in some areas. Between 6 and 14 in (152-356 mm) fell between the Olympic and Cascade Mountains, from Seattle to Everett. Exposed areas along Puget Sound were pounded by strong winds and 4–to 8–ft (1.2–2.4 m) waves through the 19th.

On the 18th and 19th, a 14–ft (4 m) section of Redondo Beach Drive fell into Puget Sound during the pounding from strong winds and waves. Two people died during the storm. In Kitsap County the Seabeck Marina was heavily damaged.

Another strong arctic front moved through Washington State on the 28th. The combination of high tides and strong north winds once again caused substantial damage along exposed waterfront areas (back cover).

This storm also resulted in two deaths, when trees fell on automobiles. Winds gusted to 68 kn (126 km/h) at Hood Canal Bridge, 55 kn (102 km/h) at Bellingham and 50 kn (93 km/h) at Whidbey Is NAS.

Coming Attractions

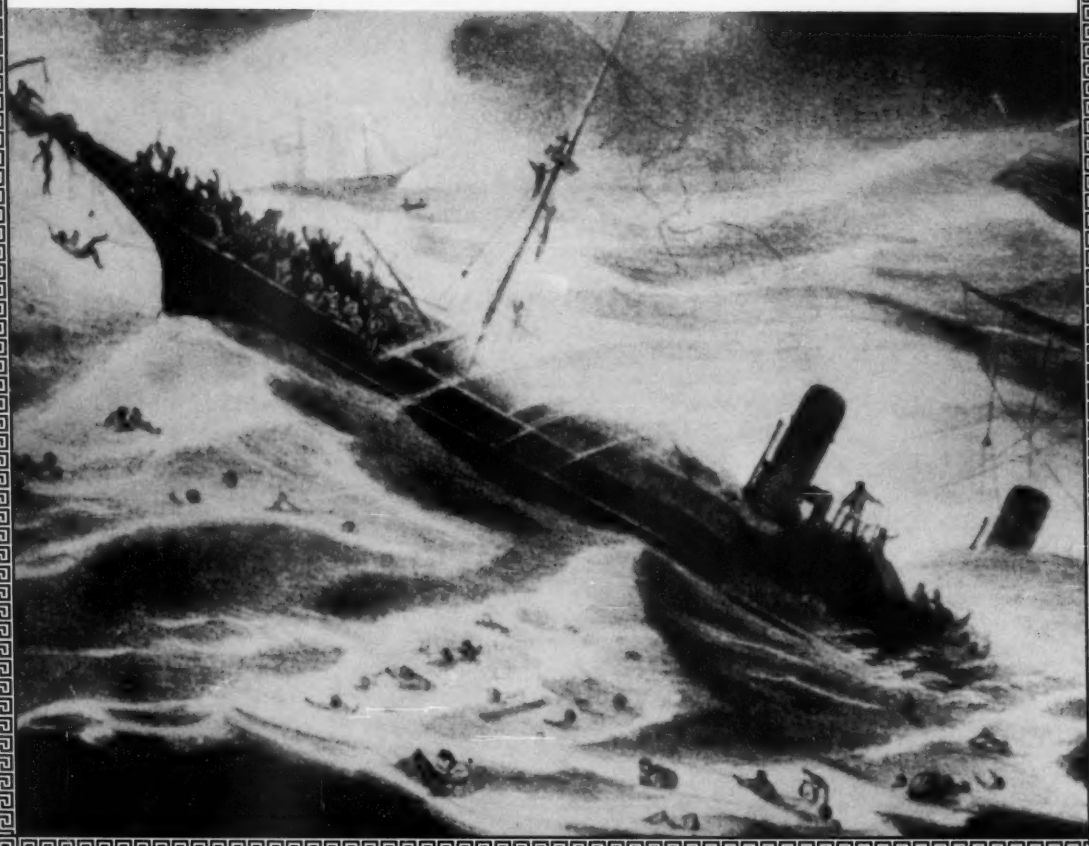
In the Next Issue of the Mariners Weather Log

The Central America Expedition

by the

Columbus America Discovery Group

✣ Hurricanes ✣ Gold ✣ Undersea Adventure ✣ VOS Ship Arctic Discoverer



Principal Tracks of Cyclone C

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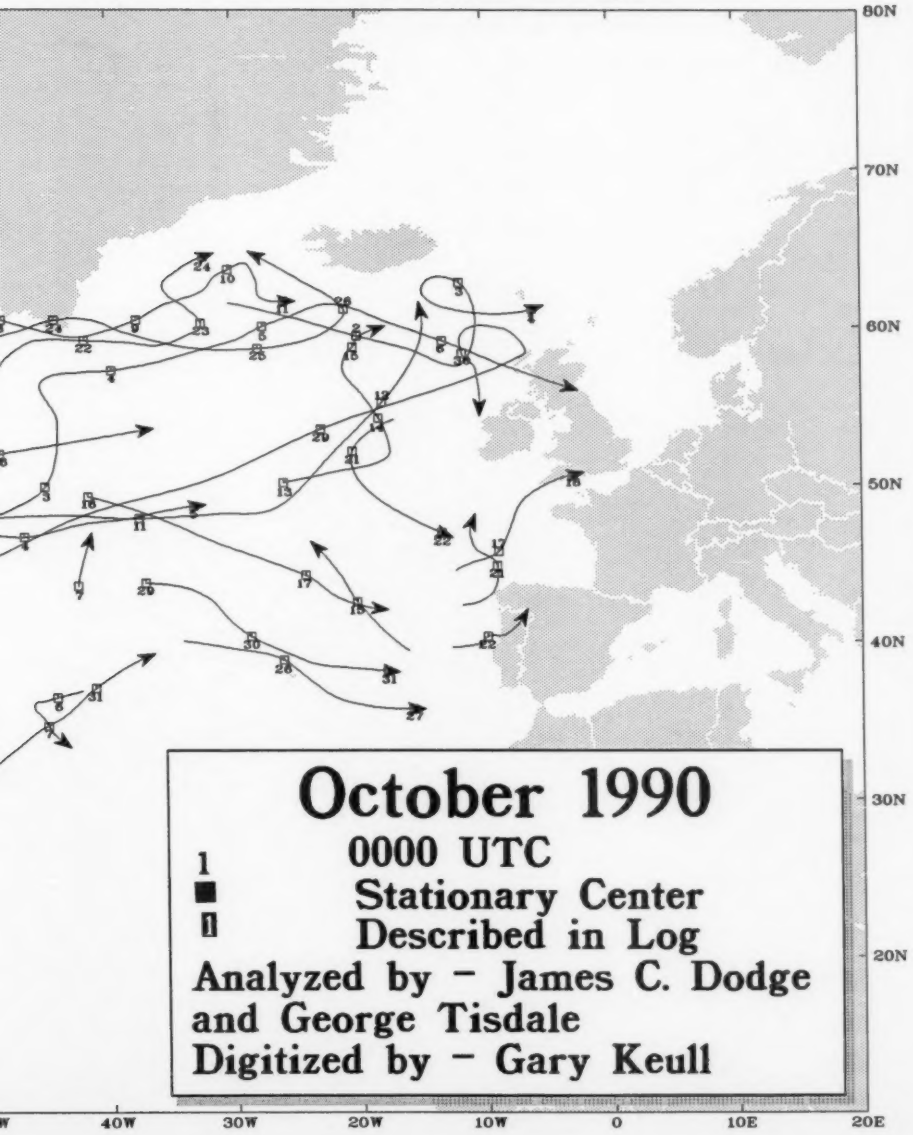

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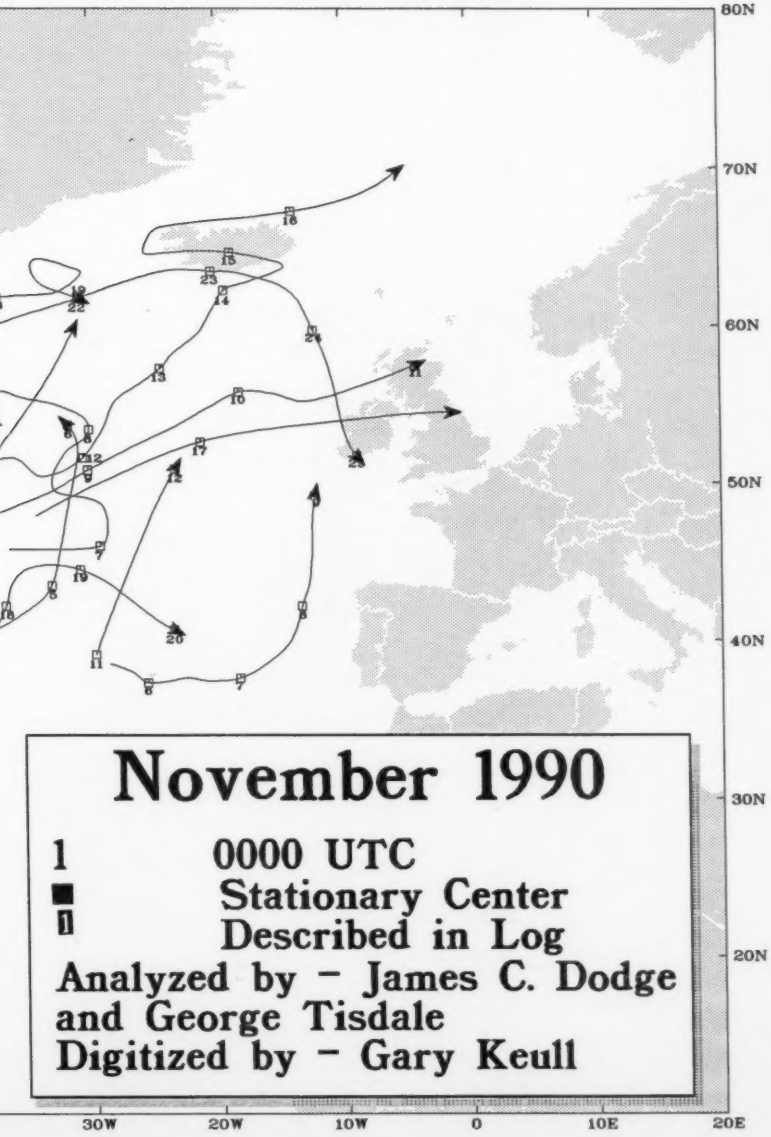

Principal Tracks of Cyclone Centers a

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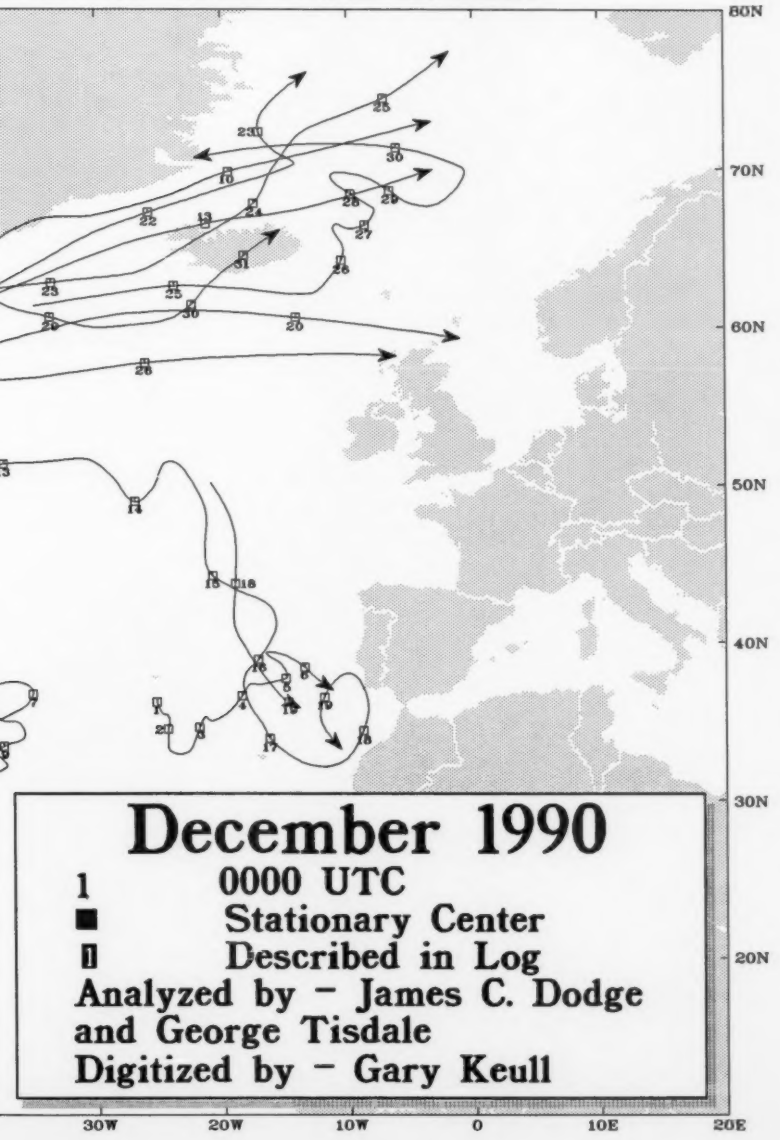

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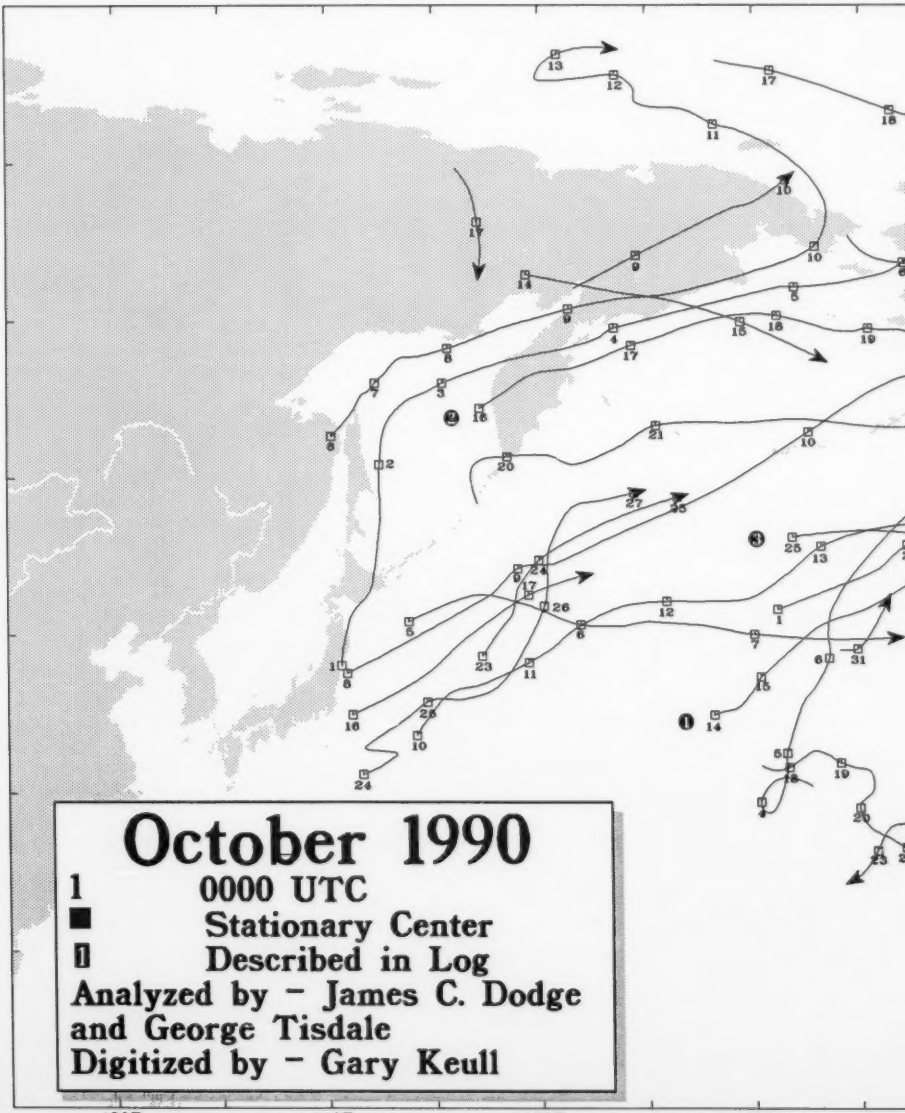

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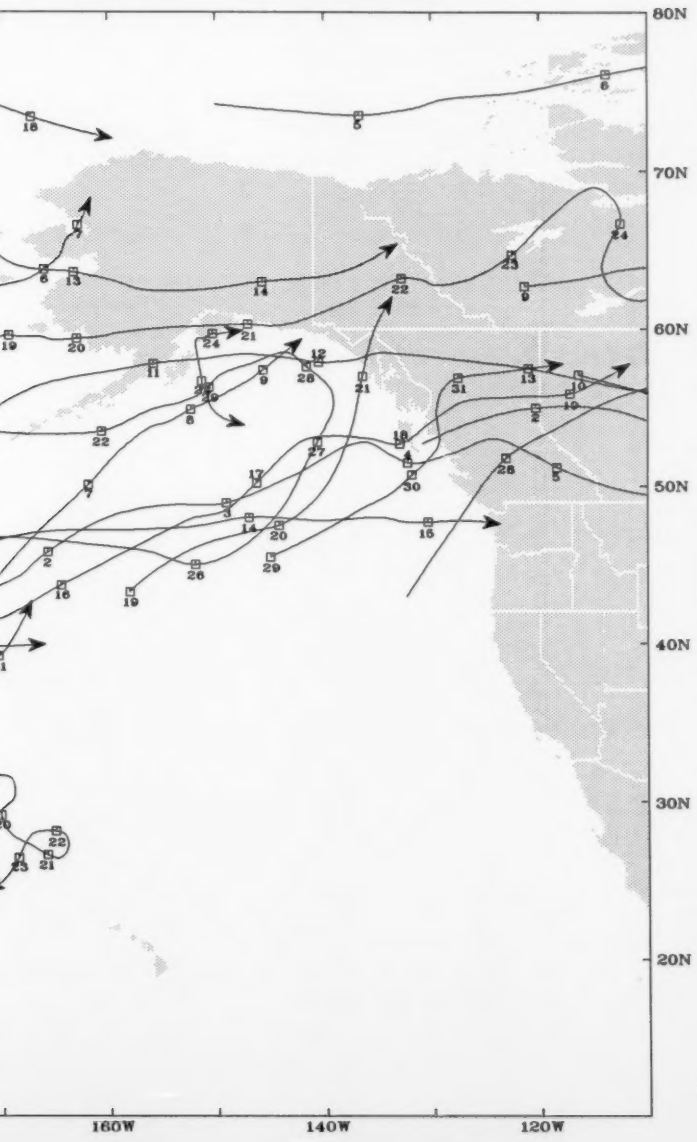
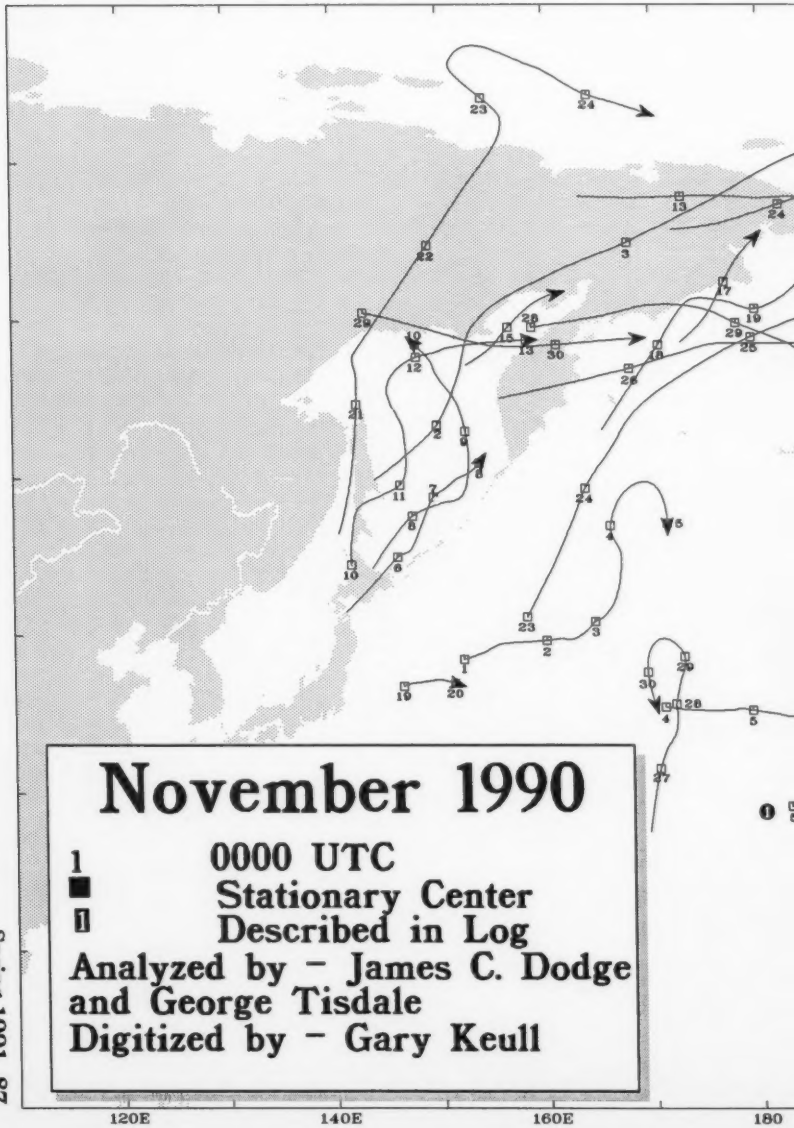


Principal Tracks of Cyclone Center



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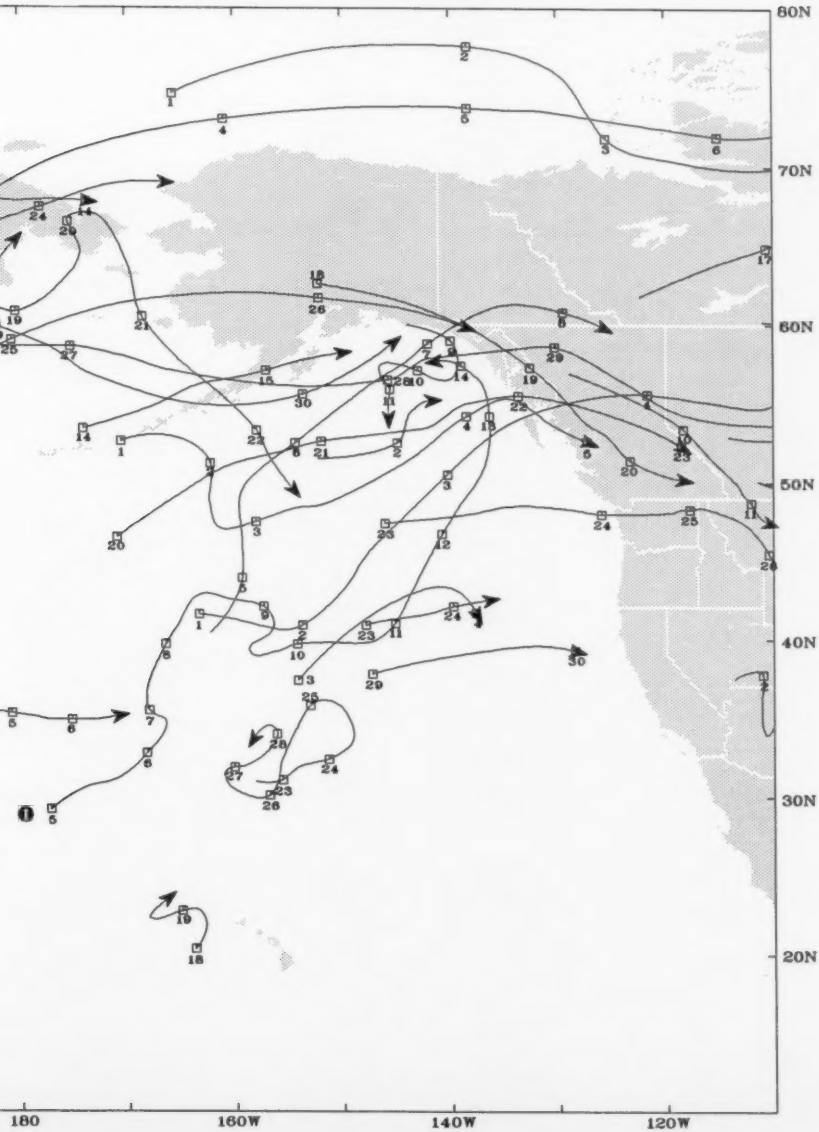

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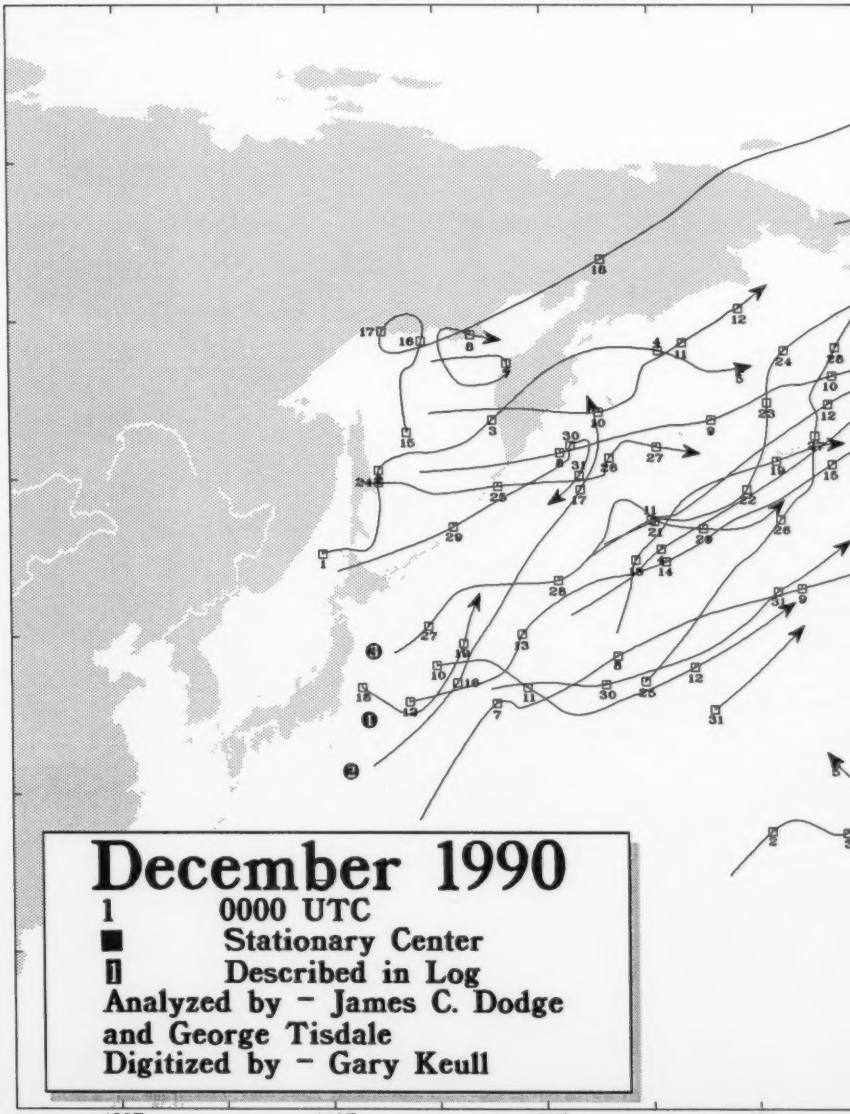

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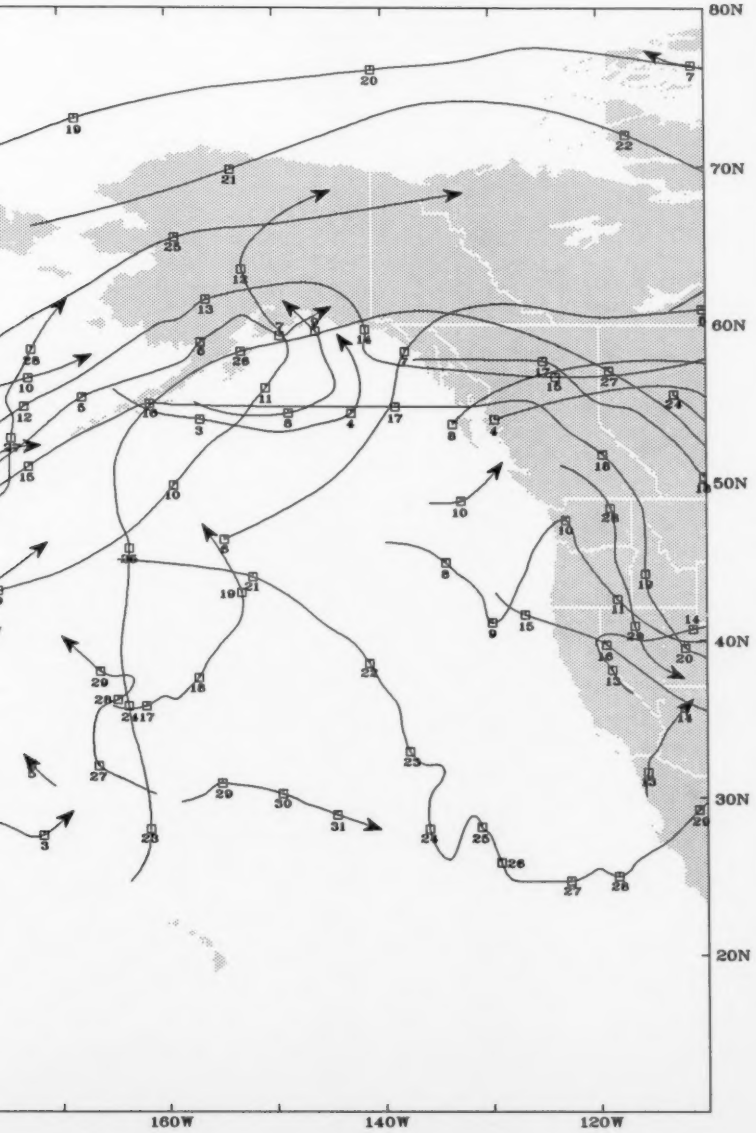

When it's done holding your ship's garbage, it could hold death for some marine animals.

This plastic trash bag may not look like a jellyfish to you. But to a hungry sea turtle, it might. And when the turtle swallows an empty bag, the mistake becomes fatal.

The problem is more than bags. Plastic six-pack holders sometimes become lodged around the necks and bills of pelicans and other seabirds, ultimately strangling or starving them. Other plastic refuse, either through ingestion or entanglement, causes the deaths of thousands of seals, whales, dolphins and other marine mammals every year.

Plastic debris also causes costly and potentially hazardous delays to shipping when it fouls propellers or clogs intake ports.

It's a critical issue, destined to attract public and government scrutiny if we fail to take action to solve it.

So please, stow your trash, and alert your shipping terminals that you will need proper disposal on land. A sea turtle may not know any better. But now, you do!

To learn more about how you can help, write: Center for Marine Conservation, 1725 De Sales Street, N.W., Suite 500, Washington, D.C. 20036.

A public service message from:
The Center for Marine Conservation
The National Oceanic and Atmospheric Administration
The Society of the Plastics Industry

Selected Gale and Wave Observations

October, November and December 1990

VESSEL	SHIP CALL	DATE	POSITION LAT. deg.	POSITION LONG. deg.	TIME GMT	WIND DIR. 10 deg.	WIND	WIND SPEED kn.	VSBY	PRES WX. code	PRESSURE hPa	TEMP deg C. Air	TEMP deg C. Sea	SEA WAVES PD. sec	SEA WAVES HGT. ft.	SWELL WAVES DIR	SWELL WAVES PD. sec	SWELL WAVES HGT. ft.
					PACIFIC	**OCT.**												
PRESIDENT MONROE	WNRD	8	44.2 N	159.3 W	18	03		55	5 NM	07	1000.5	10.0		9	29.5	05	14	32.5
SOARER CUPID	3EPM4	17	49.0 N	135.9 W	18	26	M	53	1 NM	60	0985.3	10.5	13.0	10	6.5	25	10	39
SOARER CUPID	3EPM4	18	48.9 N	136.0 W	00	29	M	48	2 NM	60	0997.3	11.5	14.0	8	29.5	29	10	29.5
SANSINENA II	WSIN	26	56.1 N	139.3 W	23	10	M	67	.25 NM		0972.3	6.7	8.3	8	29.5			
SANSINENA II	WSIN	27	55.7 N	138.8 W	06	13	M	45	2 NM	81	0958.0	7.8	8.9	8	42.5	14	8	42.5
SANSINENA II	WSIN	27	55.3 N	138.0 W	12	18	M	64	1 NM		0968.0	5.6	8.9	10	34.5			
TONSINA	KJDG	30	50.1 N	132.3 W	00	30	M	49	5 NM	82	0974.0	7.7	9.0	14	31	30	12	29.5
PRESIDENT GRANT	WEZD	30	49.8 N	130.5 W	06	23		50	5 NM	02	0984.2	8.9	11.7	6	19.5	23	10	32.5
					PACIFIC	**NOV.**												
TAMPA	LMWO3	6	35.5 N	171.2 W	18	20	M	50	1 NM	80	0998.5	16.0		6	29.5	20	6	29.5
CHESAPEAKE TRADER	WGZK	9	46.4 N	130.1 W	12	23		45	1 NM		1015.5	12.8		4	13	22	8	32.5
PRESIDENT TRUMAN	WNDP	10	36.8 N	145.8 E	06	22	M	48	1 NM	65	0994.5	21.1	23.7	16	32.5	18	10	24.5
SANSINENA II	WSIN	12	53.2 N	141.5 W	18	34	M	51	2 NM	69	0977.0	- 1.0	7.2	8	26	02	10	49
CHESAPEAKE TRADER	WGZK	22	53.5 N	137.4 W	00	29		45	5 NM		0977.1	3.3		5	11.5	23	12	37.5
SANSINENA II	WSIN	22	53.5 N	140.1 W	00	31	M	45	2 NM	82	0982.8	3.3	8.3	6	13	23	12	34.5
CHESAPEAKE TRADER	WGZK	24	48.5 N	124.7 W	00	20		47	2 NM	63	1000.3	11.1		4	18	20	10	41
NEPTUNE AMBER	S6CY	29	39.8 N	167.6 E	06	35	M	51	.25 NM	53	0989.0	14.0				09	12	42.5
CHESAPEAKE TRADER	WGZK	29	54.4 N	136.1 W	06	27		50	10 NM	22	0996.0	3.3		4	14.5	28	9	31
NEPTUNE AMBER	S6CY	29	38.7 N	165.8 E	12	34	M	49	.25 NM	07	0994.8	13.8		8	10	35	12	37.5
NEPTUNE AMBER	S6CY	29	37.7 N	163.7 E	18	34	M	49	.25 NM	07	1002.0	12.4				09	12	39
PRESIDENT ADAMS	WRYW	30	39.2 N	165.9 E	00	02	M	46	5 NM	25	0998.0	17.4	19.4	10	32.5			
SKAUBORD	LADC2	30	35.8 N	142.5 E	06	10	M	48	.5 NM	65	1009.0	19.0	23.5	10	34.5	10	12	37.5
PRESIDENT TYLER	WEZM	30	35.5 N	141.3 E	06	10	M	52	1 NM	63	1005.0	18.3	22.2	16	32.5			
CHESAPEAKE TRADER	WGZK	30	56.9 N	140.1 W	06	29		46	5 NM	22	0999.0	- 1.1		3	18	31	10	36
PRESIDENT ADAMS	WRYW	30	38.7 N	163.4 E	06	02	M	50	2 NM	25	1010.0	14.0	19.1	8	32.5	02	8	24.5
SKAUBORD	LADC2	30	36.2 N	143.3 E	12	10	M	51	.5 NM	65	1007.0	19.0	23.0	12	42.5	10	14	46
SKAUBORD	LADC2	30	36.4 N	144.2 E	18	13	M	51	.25 NM	65	0999.0	20.0	22.5	12	41	12	15	44
					ATLANTIC	**NOV.**												
LOUISIANA	KDZF	27	39.2 N	51.7 W	06	27		50			1015.5	16.1	20.6	6	19.5	27	10	34.5
LOUISIANA	KDZF	27	39.2 N	52.5 W	12	32		50	10 NM	03	1020.0	14.4	20.6	6	23	32	8	41
					PACIFIC	**DEC.**												
SANSINENA II	WSIN	4	48.0 N	130.0 W	00	23	M	50	2 NM	81	0990.1	9.1	9.4	8	23	21	13	36
PRESIDENT MADISON	WCIP	5	49.1 N	173.8 E	00	30		55	5 NM	25	0988.8	4.4	4.4	6	16.5	27	12	36
PRESIDENT MADISON	WCIP	5	47.2 N	170.7 E	18	31		50	5 NM	25	1004.0	3.3	5.6	6	29.5	27	11	29.5
PETROBULK PROGRESS	C6JK6	13	35.3 N	158.1 E	00	27	M	66	1 NM	82	1000.1	17.5	22.0	9	24.5	27	12	32.5
ARTHUR MAERSK	OXRS2	13	45.4 N	161.9 E	06	22		50	1 NM		0989.5	6.5	11.0	16	32.5			
PRESIDENT KENNEDY	WRYE	20	37.7 N	168.7 E	12	26	M	50	5 NM	07	0997.2	14.5	16.3	10	29.5	16	10	26
PRESIDENT KENNEDY	WRYE	21	36.9 N	165.2 E	00	29	M	45	10 NM	07	1004.4	13.0	17.8	12	32.5	27	12	32.5
					ATLANTIC	**DEC.**												

NONE

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Michigan Sea Grant College Program
The University of Michigan
2200 Bonisteel Boulevard
Ann Arbor, MI 48109

October, November and December 1990

Ship Name	radio	mail
1ST LT ALEX BONNYMAN	24	41
1ST LT JACK LUMMIS	48	59
2ND LT. JOHN P. BOBO	14	
A. V. KASTNER	131	20
ACADIA FOREST	132	
ACE ACCORD	31	14
ACT 10	17	
ACT 111	145	
ACT 12	142	
ACT 5	183	
ACT 6	213	
ACT 7	186	
ACT I	149	
ACT IV	149	
ADABELLE LYKES	66	59
ADDIRIYAH	75	85
ADMIRALTY BAY	7	
ADRIAN MAERSK	11	34
ADVANTAGE	8	
AINO	89	173
ALASKA MARU	110	
ALASKA RAINBOW	45	
ALBERT MAERSK	12	44
ALDEN W. CLAUSEN	17	9
ALEMANIA EXPRESS	48	
ALLIGATOR EXCELLENCE	31	
ALLIGATOR FORTUNE	26	15
ALLIGATOR HOPE	58	103
ALLIGATOR JOY	48	159
ALLIGATOR LIBERTY	30	
ALLIGATOR PRIDE		100
ALLIGATOR SYMPHONY	52	
ALLIGATOR TRIUMPH	16	
ALMERIA LYKES	56	101
ALPHA HELIX	11	14
ALTAMONTE	41	32
AMBASSADOR		23
AMBASSADOR BRIDGE	83	52
AMERICA EXPRESS	61	
AMERICAN CONDOR	47	23
AMERICAN CORMORANT	1	2
AMERICAN EAGLE	30	10
AMERICAN FALCON	25	28
AMERICAN MARINER	1	
AMERICAN REPUBLIC	50	101
AMERICAN TRADER	41	86
AMERICANA	37	54
AMERIGO VESPUCCI	23	46
ANASTASTS	16	
ANDERS MAERSK	55	109
ANGLO TURQUOISE	48	105
ANTHONY RAINBOW	15	36
ARCO ALASKA	37	19
ARCO ANCHORAGE	40	32
ARCO CALIFORNIA	37	46
ARCO FAIRBANKS	25	
ARCO INDEPENDENCE	4	6
ARCO JUNEAU	28	
ARCO PRUDHOE BAY	19	50
ARCO SAG RIVER	10	26
ARCO SPIRIT	23	46
ARCO TEXAS	33	44
ARCTIC DISCOVERER	13	
ARCTIC OCEAN	9	16
ARCTIC TOKYO	82	143
ARGONAUT	38	85
ARMCO	105	117
ARNOLD MAERSK	11	38
AROSIA	134	84
ARTHUR M. ANDERSON	170	184
ARTHUR MAERSK	38	102
ASHLEY LYKES	56	83
ASPEN	53	54
ASTRO JYOJIN	10	85
ASTRO VENUS	1	
ATIGUN PASS	37	104
ATLA	7	4
ATLANTIC	8	
ATLANTIC CARTIER	98	
ATLANTIC COMPASS	20	
ATLANTIC CONVEYOR	80	
ATLANTIC OCEAN	111	59
ATLANTIS II	28	
ATLAS HIGHWAY	57	72
AUSTRAL RAINBOW	50	56
AXEL MAERSK	61	122
B.T. SAN DIEGO	83	210

Ship Name	radio	mail
BACTAZAR	15	
BADGER	35	55
BALTIMORE TRADER	58	181
BAY BRIDGE	137	155
BCR KING	54	
BEATE OLDENDORFF	12	
BEBEDOURO	30	66
BEER SHEVA	3	
BELGIAN SENATOR	21	
BIBI	129	
BLUE HAWK	103	
BOGASARI LIMA	68	224
BOHOL SAMPAGUITA	8	
BOWN EXPRESS	144	
BOW SELENE	8	
BRIGIT MAERSK	37	
BRILLIANT ACE	148	
BROOKLYN	11	
BROOKLYN BRIDGE	43	26
BROOKS RANGE	38	
BUFFALO	9	
BUNGA KANTAN	44	24
BUNGA KENANGA	1	
BUNGA KESIDANG	3	
BUNGA MELAWIS	10	
BURNS HARBOR	147	281
CALCITE II	148	158
CALIFORNIA	8	
CALIFORNIA CARRIER	132	
CAPE ALEXANDER	7	19
CAPE BLANCO	9	17
CAPE BON	11	
CAPE BORDA	20	79
CAPE BOVETON	59	106
CAPE COD	2	
CAPE DECISION	3	
CAPE DOUGLAS	12	
CAPE EDMONT	18	9
CAPE FLORIDA	9	
CAPE GIBSON	42	70
CAPE GIRARDEAU	51	101
CAPE HENRY	84	
CAPE HORN	3	22
CAPE HUDSON	2	14
CAPE INSCRIPTION	36	5
CAPE JUBY	10	17
CAPE LAMBERT	24	
CAPE LOBOS	43	113
CAPE MENDOCINO	34	
CARIBAN	104	48
CARIBE 1	2	54
CARLA A. HILLS	9	102
CARMAN	15	
CARMEL	36	183
CAROLINA	2	57
CARTAGENA	112	114
CASON J. CALLAWAY	184	208
CATTLEYA ACE		33
CELEBRATION	2	
CENTURY HIGHWAY #2	329	82
CENTURY HIGHWAY NO. 5	251	96
CGM ILE DE FRANCE	106	140
CGM LORRAINE	32	
CGM PROVENCE	163	
CHABLIS	24	22
CHACO	26	
CHALLENGER	88	
CHARLES E. WILSON	225	195
CHARLES M. BEEGHLEY	88	57
CHARLOTTE LYKES	79	106
CHEMICAL PIONEER	67	80
CHERRY VALLEY	35	13
CHESAPEAKE TRADER	75	149
CHESNUT HILL	10	
CHEVRON ANTWERP	16	47
CHEVRON BURNABY	23	35
CHEVRON CALIFORNIA	119	130
CHEVRON COLORADO	62	124
CHEVRON COPENHAGEN		39
CHEVRON EDINBURGH	62	
CHEVRON LONDON		35
CHEVRON LOUISIANA	45	73
CHEVRON OREGON	9	
CHEVRON PACIFIC	23	202
CHEVRON SKY		77
CHEVRON STAR		92
CHEVRON WASHINGTON	3	1

Ship Name	radio	mail
CHINA CONTAINER	89	88
CHIQUITA BOCAS	125	
CHOAPA	66	52
CITADEL HILL	37	
CLARENCE	151	
CLEMENT	43	
CLEMENTINA	46	
CLEVELAND	22	110
COAST RANGE	44	83
COASTAL CORPUS CHRISTI	30	22
COLIMA	10	
COLUMBIA STAR	73	177
COLUMBINE	28	37
COLUMBUS AMERICA	280	
COLUMBUS AUSTRALIA	188	
COLUMBUS CANADA	208	
COLUMBUS LOUISIANA	45	
COLUMBUS NEW ZEALAND	135	
COLUMBUS OHIO	108	231
COLUMBUS OLIVOS	51	55
COLUMBUS ONTARIO	12	
COLUMBUS QUEENSLAND	89	
COLUMBUS VICTORIA	246	
COLUMBUS VIRGINIA	66	
COLUMBUS WELLINGTON	129	
COMPANION EXPRESS	40	
CONCERT EXPRESS	47	
CONCHO	1	
CONSENSUS SEA	25	
CONTIENTAL WING	55	47
CONTINENTAL HIGHWAY	40	
CONTSHIP AUSTRALIA	31	
CONTSHIP SPAIN	39	108
CORAH ANN	14	
CORMORANT ARROW	69	89
CORNUCOPIA	29	30
CORONADO	32	5
COURTNEY BURTON	197	233
CPL. LOUIS J. HAUGE JR	14	46
CRISPEN OGLEBAY	44	45
CRISTOFORO COLOMBO	14	24
CSS HUDSON	68	
CYPRESS TRAIL	32	
D. L. BOWER		113
DAVID PACKARD		7
DEL MONTE PACKER		44
DEL VALLE	5	
DELAWARE TRADER	38	119
DEPPE AMERICA	82	
DIANA	3	14
DOLE ECUADOR	25	130
DON JORGE	35	20
DONAIRE		153
DUSSELDORF EXPRESS	64	
EASTERN GLORY	34	112
EASTERN VENTURE	35	32
EDEN	36	169
EDGAR B. SPEER	246	155
EDWARD L. RYERSON	51	181
EDWIN H. GOTT	233	257
ELIZABETH LYKES	52	56
EMERALD SEA	161	118
ENDEAVOR	20	31
ENSOR	118	106
ESSO PUERTO RICO	18	50
ETERNITY	133	169
EVER GAINING	17	
EVER GALLANT	13	13
EVER GARDEN	11	
EVER GENERAL	14	49
EVER GENIUS	6	21
EVER GENTLE	30	13
EVER GENTRY	13	40
EVER GIANT		11
EVER GIFTED	3	
EVER GIVEN	17	6
EVER GLAMOUR	7	12
EVER GLOBE	22	44
EVER GLOWING	15	4
EVER GOING	28	42
EVER GOVERN	25	
EVER GROWTH	3	
EVER GUIDE	8	
EVER LAUREL	17	28
EVER LEVEL	20	20
EVER LINKING	11	16
EVER LIVING	19	10
EVER LOADING	6	10

Ship Name	radio	mail
EVER LYRIC	6	37
EXPORT FREEDOM	44	77
EXPORT PATRIOT	32	128
EXXON BATON ROUGE	33	40
EXXON LONG BEACH	14	9
EXXON MEDITERRANEAN	9	6
EXXON NEW ORLEANS	8	24
EXXON NORTH SLOPE		5
EXXON PHILADELPHIA	37	
EXXON WILMINGTON		1
FAIRLIFT	59	
FALCON CHAMPION	8	55
FALSTAFF	12	
FALSTRIA	40	33
FARNELLA	181	
FAUST	64	72
FERNCROFT	141	217
FESTIVALE	50	85
FETISH	137	53
FIGARO	8	
FLICKERTAIL STATE	36	118
FLORIDA RAINBOW	40	37
FORTALEZA	82	217
FRANCES HAMMER	14	
FRANCIS SINCERE NO. 6	49	
FRED R. WHITE JR	12	66
FROTASIRIUS	58	
FUJI	43	37
GALVESTON BAY	85	154
GATEWAY EAST	36	82
GEMINI	70	111
GENEVIEVE LYKES	27	62
GEORGE A. SLOAN	135	107
GEORGE A. STINSON	90	174
GEORGE WASHINGTON BRID	188	
GEORGIA		84
GERMAN SENATOR	77	
GERONIMO	18	24
GLACIER BAY	41	21
GLOBAL FAME	43	48
GLORIOUS SPICA	46	
GOLDEN ENDEAVOR	23	86
GOLDEN GATE	5	8
GOLDEN GATE BRIDGE	209	63
GOLDEN TOPAZ	25	9
GOPHER STATE	21	52
GRAIGLAS	121	
GREAT LAND	229	281
GREAT RIVER	25	137
GREEN ANGELES	1	
GREEN BAY	109	149
GREEN ENGELES	35	93
GREEN HARBOUR	44	76
GREEN ISLAND	21	17
GREEN KOBE	50	96
GREEN LAKE	33	78
GREEN MAYA	73	98
GREEN RAINIER	24	30
GREEN RIDGE	114	125
GREEN SAIKAI	10	124
GREEN SUMA	19	110
GREEN VALLEY	35	43
GREEN WAVE	15	81
GUANAJUATO	141	98
GUAYAMA	42	73
GULF BANKER	6	
GULF SENTRY	16	134
GULF SPEED	21	
GULF SPIRIT	55	
GYPSUM BARON	145	
GYPSUM KING	154	
GYRE	1	
HAKONE MARU	109	
HANEI SKY	44	93
HANEI SUN	49	9
HANJIN BUSAN	40	38
HANJIN CHEJU	41	18
HANJIN CHUNGMU	23	
HANJIN HONG KONG	33	17
HANJIN KEELUNG	30	
HANJIN KOBE	24	
HANJIN KUNSAN	40	17
HANJIN KWANG YANG	29	7
HANJIN LONG BEACH	21	
HANJIN MASAN	15	12
HANJIN NEW YORK	24	
HANJIN POHANG	37	20
HANJIN SAVANNAH	29	22
HANJIN SEATTLE	35	27
HANJIN SEOUL	52	20
HANJIN TONGHAE	41	12
HANJIN YOKOHAMA	25	46
HANNOVERLAND	172	
HARMAC DAWN	23	

Ship Name	radio	mail
HAWAIIAN RAINBOW	50	41
HEIDELBERG EXPRESS	39	
HENRY HUDSON BRIDGE	198	
HERBERT C. JACKSON	129	82
HESIOD	28	
HIBISCUS	9	27
HIRA II	95	56
HOEGH CAIRN	18	
HOEGH CLIPPER	14	
HOEGH DENE	7	
HOEGH DUKE	20	
HOEGH DYKE	22	
HOEGH MASCOT	6	26
HOEGH MIRANDA	47	81
HOLIDAY	4	7
HOLLANDIC	22	59
HOLSTEN CARRIER	58	
HONOLULU	155	
HOWELL LYKES	34	52
HUAL ANGELITA	36	19
HUMACAO	63	154
HUMBER ARM	22	
HYUNDAI #101	24	
HYUNDAI #201	17	
HYUNDAI #203	41	
HYUNDAI CHALLENGER	15	5
HYUNDAI COMMANDER	22	14
HYUNDAI CONTINENTAL	19	
HYUNDAI EXPLORER	37	
HYUNDAI NO 102	42	
HYUNDAI PIONEER	22	
IBIS ARROW	12	
INCOTRANS PACIFIC	16	
INDEPENDENT SPIRIT	18	
INDIAN OCEAN	12	25
INFANTA	126	
INGER	77	93
IRVING L. CLYMER	30	34
ISLAND PRINCESS	43	
IST LT BALDOMERO LOPEZ	17	37
ITAITE	27	
ITAPE	40	
ITB BALTIMORE	47	92
ITB CHARLESTON	38	45
ITB NEW YORK	41	12
ITB PHILADELPHIA	73	58
J. BURTON AYERS	163	172
J.L. MAUTHE	34	69
JALISCO	66	28
JAMES LYKES	25	31
JAMES R. BARKER	180	209
JAPAN ALLIANCE	178	101
JAPAN APOLLO	91	93
JAPAN CARRYALL	12	
JEAN LYKES	45	80
JO BIRK	52	
JO CLIPPER	148	
JO CYPRESS	139	
JO LONN	96	
JO OAK	94	
JO ROGN	20	
JOHN G. MUNSON	184	206
JOHN LYKES	58	
JOHN YOUNG		191
JOSEPH H. FRANTZ	241	222
JOSEPH LYKES	37	
JOVIAN LILY	47	229
JOVIAN LUZON	147	191
JULIUS HAMMER	119	57
JUPITER	3	
K. TOPIC	54	
KAIMOKU	64	199
KAINULA	38	128
KALIDAS	2	
KATHLEEN PEARCY	25	
KAUAI	78	189
KAYE E. BARKER	431	408
KEE LUNG	4	31
KEISHO MARU	57	
KENAI	58	
KENNETH E. HILL	70	191
KENNETH T. DERR		14
KENTUCKY HIGHWAY	65	
KEYSTONE CANYON	34	78
KEYSTONER	28	96
KISO	73	
KITTANING	37	65
KORUA	5	
KOLN ATLANTIC	121	
KUROBE	89	
LASH ATLANTICO	17	28
LAURA MAERSK	29	93
LAWRENCE H. GIANELLA	76	
LESLIE LYKES	22	18

Ship Name	radio	mail
LETITIA LYKES	42	14
LEWIS WILSON FOY	319	413
LIBERTY STAR	59	50
LIBERTY SUN	77	3
LIBERTY WAVE	15	
LILAS	27	139
LINDOE MAERSK	60	67
LIRCAY	109	
LNG AQUARIUS	16	66
LNG CAPRICORN	16	17
LNG LEO	57	156
LNG LIBRA	55	42
LNG TAURUS	16	120
LONDON SENATOR	170	
LONG LINES	36	71
LOTUS ACE	94	
LOUIS MAERSK	36	71
LOUISE LYKES	33	75
LOUISIANA		151
LOUISIANA BRIMSTONE	30	31
LT. ODYSSEY	49	
LURLINE	29	141
LYRA	38	
M. P. GRACE	42	
MAASSLOT	154	
MACKINAC BRIDGE	205	40
MAERSK COMMANDER	130	
MAERSK CONSTELLATION	159	192
MAERSK FINE	206	115
MAERSK SUN	54	110
MAERSK WIND	25	22
MAGALLANES	17	46
MAGIC	102	134
MAGLEBY MAERSK	2	
MAINE	7	
MAJ STEPHEN W PLESS MP	45	60
MAJESTIC MAERSK	47	55
MALINI	9	
MALLORY LYKES	35	115
MANHATTAN BRIDGE	154	
MANUKAI	56	150
MANULANI	54	162
MARATHA MAJESTY	18	
MARCHEN MAERSK	8	95
MAREN MAERSK	43	82
MARGARET LYKES	46	45
MARGRETHE MAERSK	52	63
MARIA TOPIC	7	
MARIE MAERSK	25	81
MARIF	29	22
MARINE RELIANCE	10	53
MARIT MAERSK	23	139
MARJORIE LYKES	71	74
MARLIN		80
MASON LYKES	40	61
MATHILDE MAERSK	21	54
MATSONIA	74	186
MAUI	82	122
MAURICE EWING	38	160
MAYAGUEZ	38	37
MEDALLION	109	96
MEDUSA CHALLENGER	147	191
MELBOURNE HIGHWAY	1	
MENTO		49
MERCANDIAN CONTINENT	8	
MERCANDIAN SUN II	76	42
MERCURY ACE	119	
MERIDA	65	62
MERKUR AMERICA	74	
MERKUR LAKE	11	
MERKUR PORTUGAL	44	
MESABI MINER	59	64
METTE MAERSK	74	93
MICHIGAN HIGHWAY	58	
MICRONESIAN COMMERCE	18	21
MICRONESIAN INDEPENDEN	6	
MIDDLETOWN	89	141
MINDORO SAMPAGUITA	18	
MINERVA	36	
MING COMFORT	11	21
MING ENERGY	5	
MING LONGEVITY	10	23
MING MOON	19	
MING OCEAN	21	21
MING PLENTY	11	
MING PROMOTION	3	
MING STAR	8	
MITLA	47	
MOANA PACIFIC	108	
MOBIL ARCTIC	25	91
MOKU PAHU	107	104
MONA WAVE	117	51
MONTERREY	30	
MORELLO	148	227

Ship Name	radio	mail
MORELOS	65	
MORMACSKY	51	144
MORMACSTAR	76	
MSC CHIARA	42	88
MSC SABRINA	22	37
MYRON C. TAYLOR	150	166
NAGASAKI SPIRIT	126	122
NANCY LYKES	80	
NARA	31	40
NATIONAL DIGNITY	31	149
NATIONAL HONOR	29	86
NATIONAL PRIDE	28	35
NAVIOS UNIQUE	59	
NCC ARAR	3	11
NCC NAJRAN		19
NECHES	15	
NEDLLOYD BAHRAIN	141	
NEDLLOYD BALTIMORE	148	
NEDLLOYD BANGKOK	125	
NEDLLOYD BARCELONA	125	
NEDLLOYD HOLLAND	50	113
NEDLLOYD HUDSON	79	150
NEDLLOYD KEMBLA	81	
NEDLLOYD KINGSTON	117	
NEDLLOYD KYOTO	127	
NEDLLOYD MANILA	116	
NEDLLOYD ROTTERDAM	111	
NEDLLOYD ROUEN	108	
NEDLLOYD VAN CLOON	60	
NEPTUNE ACE	65	
NEPTUNE AMBER	102	200
NEPTUNE CORAL	50	
NEPTUNE CRYSTAL	62	54
NEPTUNE DIAMOND	183	
NEPTUNE GARNET	44	
NEPTUNE JADE	44	
NEPTUNE PEARL	50	214
NEW DUQUESA		145
NEW HORIZON	89	135
NEW LAPIS	1	
NEWARK BAY	87	122
NICOLET	38	54
NIPPON HIGHWAY	60	43
NISSAN MARU	119	46
NOAA DAVID STARR JORDA	126	172
NOAA SHIP CHAPMAN	152	181
NOAA SHIP DAVIDSON	12	
NOAA SHIP DELAWARE II	274	117
NOAA SHIP DISCOVERER O	382	421
NOAA SHIP FERREL	97	
NOAA SHIP HECK 591		15
NOAA SHIP M. BALDRIDGE	108	99
NOAA SHIP MCARTHUR	387	471
NOAA SHIP MILLER FREEM	90	123
NOAA SHIP MT MITCHELL	270	256
NOAA SHIP OREGON II	181	250
NOAA SHIP RAINIER	73	90
NOAA SHIP RUDE 590		9
NOAA SHIP SURVEYOR	145	
NOAA SHIP T. CROMWELL	214	267
NOAA SHIP WHITING	288	315
NOBEL STAR	77	111
NOMADIC LADY		38
NOSAC EXPLORER	22	45
NOSAC EXPRESS	18	25
NOSAC RANGER	60	8
NOSAC TAI SHAN	34	44
NOSAC TAKARA	7	
NOSAC TAKAYAMA	88	
NOVA EUROPA	65	208
NUEVO SAN JUAN	30	94
NURNBERG ATLANTIC	99	
OAXACA	74	
OCEAN BRIDGE	2	3
OCEAN CONQUEROR	85	
OCEAN HIGHWAY	70	
OCEAN ISLAND	23	
OCEAN LILY	11	
OCEAN MASTER	25	26
OCEAN SEL	64	159
OCEAN SPIRIT	4	
OLEANDER	47	43
OLGA TOPIC	2	56
OMI MISSOURI	64	70
OMI WABASH	68	59
OOCL CHARGER	36	
OOCL DOMINANCE	10	
OOCL EDUCATOR	67	77
OOCL EXECUTIVE	70	36
OOCL FAIR	63	36
OOCL FAITH	25	25
OOCL FORTUNE	39	22
OOCL FRIENDSHIP	45	43
ORANGE BLOSSOM	95	215
ORANGE STAR	83	83
ORCHID	28	137
ORCHID #2	39	38
OREGON RAINBOW II	62	105
ORIENTAL DIPLOMAT	35	
ORIENTAL EXPLORER	91	65
ORIENTAL FERM	29	32
ORIENTAL FREEDOM	84	
ORIENTAL PATRIOT	49	
ORION HIGHWAY	77	168
OSPREY ARROW	35	
OVERSEAS HARRIET	25	29
OVERSEAS JOYCE	71	75
OVERSEAS JUNEAU		85
OVERSEAS MARILYN	31	36
OVERSEAS NEW ORLEANS	28	34
OVERSEAS OHIO	7	10
OVERSEAS PHILADELPHIA	39	47
OVERSEAS VALDEZ	1	
OVERSEAS VIVIAN	20	
OVERSEAS WASHINGTON		15
PACBARON	16	
PACDUCHESS	76	39
PACDUKE	27	
PACGLORY	38	
PACIFIC ARROW	28	18
PACIFIC EMERALD	29	123
PACIFIC PRINCESS	91	
PACIFIC SENTRY	13	29
PACKING	61	34
PACMERCHANT	77	
PACNOBLE	14	
PACOCEAN	12	
PACPRINCE	9	
PACPRINCESS	79	
PACSEA	7	
PACSTAR	24	
PACSUN	22	
PACTRADER	5	
PAGA	31	
PAPAGO	31	
PAPYRUS	41	104
PATRIOT	35	
PAUL BUCK	7	
PAUL H. TOWNSEND	201	264
PECOS	14	16
PEGGY DOW	160	
PELANDER	24	12
PENNSYLVANIA TRADER	24	45
PERMEKE	80	139
PETER W. ANDERSON	67	38
PETROBULK PROGRESS	115	64
PFC DEWAYNE T. WILLIAM	1	
PFC EUGENE A. OBREGON	5	
PFC JAMES ANDERSON JR	82	55
PFC WILLIAM B. BAUGH	14	30
PHAROS	158	
PHILIP R. CLARKE	117	129
PHILLIPS VENEZUELA		95
PHOENIX DIAMOND	10	
PINE FOREST	34	112
POLAR ALASKA	2	124
POLYNESIA	177	253
POMEROL	29	29
POQUITA MAMI	61	
POTOMAC TRADER	42	92
PRESIDENT ADAMS	161	144
PRESIDENT ARTHUR	47	145
PRESIDENT BUCHANAN	48	58
PRESIDENT EISENHOWER	150	86
PRESIDENT F. ROOSEVELT	60	198
PRESIDENT GRANT	54	154
PRESIDENT HARDING	101	19
PRESIDENT HARRISON	158	
PRESIDENT HOOVER	101	88
PRESIDENT JACKSON	142	98
PRESIDENT JEFFERSON	15	44
PRESIDENT KENNEDY	53	135
PRESIDENT LINCOLN	158	176
PRESIDENT MADISON	47	142
PRESIDENT MONROE	137	158
PRESIDENT POLK	173	185
PRESIDENT TRUMAN	69	177
PRESIDENT TYLER	99	189
PRESIDENT WASHINGTON	211	
PRESQUE ISLE	127	186
PRIDE OF TEXAS	24	
PRIMORJE	22	
PRINCE OF TOKYO	67	167
PRINCE OF TOKYO 2	104	218
PRINCE WILLIAM SOUND	11	
PUERTO CORTES	107	47
PURITAN	45	
PVT HARRY FISHER	47	29
QUALITY OF LIFE	26	90
QUEEN ELIZABETH 2	88	
RAINBOW BRIDGE	84	8
RAINBOW HOPE	64	161
RALEIGH BAY	62	158
RANGER	47	
RECIFE	18	
RED ARROW	53	
REFORM	12	
RESERVE	105	133
RESOLUTE	43	137
RICHARD G MATTIESEN	5	
RICHARD REISS	1	
RIO FRIO	136	
RIO NEGRO II	3	
RIVER ETERNITY	16	
ROGER BLOUGH	135	212
ROMANEE	20	14
ROSEBANK	53	
ROSETTA	112	45
ROSINA TOPIC	18	
ROTTERDAM	26	
ROVER	72	43
ROWANBANK	54	
ROYAL PRINCESS	98	
ROYAL VIKING SKY	44	
RUBIN OCEAN	13	22
RUTH LYKES	26	
S.T. CRAPO	227	324
SALINAS	30	92
SAM HOUSTON	28	
SAMU	57	109
SAMUEL L. COBB	50	42
SAN LUIS	39	
SAN MARTIN	54	
SAN MATEO VICTORY	33	172
SANKO CATTLEYA	11	
SANKO PIONEER	3	
SANKO PRELUDE	68	118
SANSINENA II	65	113
SANTA ADELA	17	79
SANTA CRUZ	1	
SANTA JUANA	96	187
SANTA MARTA	92	
SANTA VICTORIA	4	
SANTOS	1	
SAPAI	8	
SATURN DIAMOND	61	163
SAUDI TABUK	19	
SAVANNAH	84	
SCARAB	56	
SCHACKENBORG	20	
SEA BELLS	28	22
SEA COMMERCE	234	
SEA FAN	56	119
SEA FORTUNE	30	176
SEA FOX	62	43
SEA LANTERN		178
SEA LIGHT	30	13
SEA LION	235	296
SEA MERCHANT	347	125
SEA TRADE	184	
SEA WOLF	279	236
SEALAND ACHIEVER	261	
SEALAND ANCHORAGE	79	157
SEALAND ATLANTIC	65	74
SEALAND CHALLENGER	60	52
SEALAND CONSUMER	90	135
SEALAND DEFENDER	107	160
SEALAND DEVELOPER	54	117
SEALAND DISCOVERY	42	90
SEALAND ENDURANCE	63	60
SEALAND ENTERPRISE	215	235
SEALAND EXPEDITION	6	88
SEALAND EXPLORER	57	107
SEALAND EXPRESS	67	171
SEALAND FREEDOM	54	
SEALAND HAWAII	70	70
SEALAND INDEPENDENCE	46	133
SEALAND INNOVATOR	87	
SEALAND INTEGRITY	64	121
SEALAND KODIAK	36	85
SEALAND LIBERATOR	71	91
SEALAND MARINER	76	148
SEALAND NAVIGATOR	73	29
SEALAND PACIFIC	118	144
SEALAND PATRIOT	83	106
SEALAND PERFORMANCE	29	90
SEALAND PRODUCER	66	229
SEALAND QUALITY	67	114
SEALAND SPIRIT	18	61
SEALAND TACOMA	47	160
SEALAND TRADER	198	113
SEALAND VALUE	59	167

Ship Name	radio	mail
SEALAND VOYAGER	118	155
SEAWARD BAY	28	59
SEDCO/BP 471	39	61
SEMINOLE	7	49
SENATOR	66	39
SGT. METEJ KOCAK	26	
SHELDON LYKES	103	16
SHELLY BAY	55	116
SHENAHON	12	10
SHIN BEISHU MARU	94	
SHINKASHU MARU	80	
SHIRAOI MARU	135	45
SHOSHONE SPIRIT	48	
SILVER CLIPPER	54	14
SINGAPORE VICTORY	1	
SITHEA	25	23
SKANDERBORG	105	113
SKAUBORD	59	104
SKAUGRAN	122	52
SKEENA	165	
SKODSBORG	17	
SOARER CUPID	39	126
SOLAR WING	86	119
SONBAI	1	
SONORA	35	49
SOPHIA	31	
SOUTHLAND STAR	185	
SPIRIT OF TEXAS	29	84
SPRING BEAR	205	
SPRING BEE	43	
SPRING EAGLE	2	
SPRING STORK	93	
ST EMILION	4	13
STAR CANADIAN	26	88
STAR EAGLE	57	84
STAR EVVIVA	32	56
STAR FLORIDA	90	
STAR FRASER	102	
STAR FUJI	8	
STAR GEIRANGER	11	8
STAR GRAN	61	141
STAR GRINDANGER	17	
STAR HONG KONG	24	
STAR MERCHANT		81
STAR MERIT	6	29
STAR MINERVA	33	44
STAR MUSKETEER		78
STAR OF TEXAS	12	
STAR WILMINGTON		22
STELLA LYKES	18	45
STENA TRAILER	10	
STEWART J. CORT	209	233
STONEWALL JACKSON	29	
STUTTGART EXPRESS	123	
SUE LYKES	29	47
SUGAR ISLANDER	73	15
SUNBELT DIXIE	2	107
SUNRISE RUBY	28	63
SUNWARD II	12	
SWAN LAKE	77	81
SWIFTNES	37	
TABASCO	87	83
TAI CHUNG	15	34
TAI CORN	16	
TAI SHING	2	6
TALISMAN	30	
TAMPA	37	46
TAMPA BAY	35	35
TAYABAS BAY	5	30
TEMSE	41	
TEXACO NEW YORK	21	
TEXACO WESTCHESTER	72	62
TEXAS	13	40
TEXAS CITY SEA	22	
TEXAS TRADER	18	28
THOMAS WASHINGTON	128	109
THOMPSON LYKES	14	34
THOMPSON PASS		2
TILLIE LYKES	42	133
TOBA	24	24
TOLUCA	97	86
TONCI TOPIC	5	
TONSINA	60	60
TORRENS	9	
TRANSWORLD BRIDGE	60	89
TRIGGER	101	146
TRITON	259	185
TROPIC SUN	5	
TROPICALE	25	1
TULSIDAS	10	
TUMILCO	156	91
TYSON LYKES	31	112
ULTRAMAR	12	
ULTRASEA	30	93

Ship Name	radio	mail
UNAMONTE	13	
URTE	201	188
USCGC ACACIA (WLB406)	11	26
USCGC ACTIVE WMEC 618	13	
USCGC ALERT (WMEC 630)	7	
USCGC BASSWOOD (WLB 38	25	
USCGC BISCAYNE BAY	1	3
USCGC BOUTWELL WHEC 71	11	
USCGC BRAMBLE (WLB 392	48	
USCGC BUTTONWOOD WLB 3	1	
USCGC CAMPBELL	3	
USCGC CHEROKEE WMEC 16	41	
USCGC CHILULA (WMEC 15	9	
USCGC CITRUS (WMEC 300	85	
USCGC DALLAS (WHEC 716	18	
USCGC DEPENDABLE		37
USCGC DURABLE (WMEC 62	1	
USCGC ESCAPE (WMEC 6)	90	
USCGC FIREBUSH WLB 393	32	
USCGC FORWARD	59	149
USCGC HAMILTON WHEC 71	3	
USCGC HARRIET LANE	5	29
USCGC IRONWOOD (WLB 29	85	34
USCGC KATMAI BAY	2	
USCGC LAUREL (WLB 291)	7	
USCGC LEGARE	53	
USCGC MACKINAW	21	45
USCGC MALLOW (WLB 396)	1	
USCGC MUNRO	28	
USCGC NORTHLAND WMEC 9	80	65
USCGC PLANETREE	3	
USCGC POLAR SEA WAGB 1	255	27
USCGC RELIANCE WMEC 61	81	20
USCGC SEDGE (WLB 402)	3	
USCGC SPENCER	26	
USCGC STEADFAST WMEC 6	7	
USCGC STORIS (WMEC 38)	10	
USCGC SUNDEW (WLB 404)	2	7
USCGC SWEETBRIER WLB 4	11	
USCGC TAHOMA	76	
USCGC TAMAROA (WMEC 16	27	
USCGC TAMPA WMEC 902	1	
USCGC VIGOROUS WMEC 62	3	
USCGC YOCONA (WMEC 168	1	
USNA SIOUX	71	103
USNS ALGOL	20	
USNS ALTAIR	20	145
USNS APACHE (T-ATF 172	16	56
USNS BARTLETT(T-AGOR 1		132
USNS BELLATRIX	17	29
USNS CAPELLA	38	
USNS CHAUVENET TAGS 29	21	
USNS COMET	18	41
USNS DE STEIGUER	24	66
USNS DENEBOLA	28	82
USNS GUS W. DARNELL	35	
USNS HARKNESS (T-AGS 3		233
USNS HENRY J. KAISER		21
USNS JOHN LENTHAL		127
USNS KANE TAGS 27	2	
USNS KAWISHWI	55	42
USNS LEROY GRUMMAN		22
USNS LYNCH T-AGOR 7		17
USNS MERCURY	16	
USNS MISSISSINEWA		111
USNS MOHAWK (T-ATF 170	69	
USNS NARRAGANSETT	68	68
USNS NAVAJO	29	
USNS PAWCATUCK TAO-108		153
USNS POLLUX	48	53
USNS POWHATAN TATF 166	8	
USNS RANGE SENTINEL	1	
USNS REGULUS	51	
USNS SATURN T-AFS-10		50
USNS SEALIFT ANTARCTIC	34	
USNS SEALIFT ARABIAN S		16
USNS SEALIFT ARCTIC	41	
USNS SEALIFT ATLANTIC	212	141
USNS SEALIFT CARIBBEAN	6	61
USNS SEALIFT CHINA SEA	19	51
USNS SEALIFT IND'N OCE	4	
USNS SEALIFT MEDITERRA	67	137
USNS SEALIFT PACIFIC	57	
USNS SIRIUS (T-AFS 8)		1
USNS VANGUARD TAG 194	37	
VALLEY FORGE	3	28
VAN TRADER	9	
VIKING ACE	73	55
VINE	38	
VISHVA VIKRAM	1	
WASHINGTON RAINBOW #2	72	147
WESTWARD	8	
WESTWARD VENTURE	100	73
WESTWOOD ANETTE	79	104

Ship Name	radio	mail
WESTWOOD BELINDA	5	8
WESTWOOD CLEO	130	154
WESTWOOD JAGO	142	47
WESTWOOD MARIANNE	27	91
WHITE ROSE	36	
WILFRED SYKES	64	103
WILLIAM J. DELANCEY	313	329
WINDWARD SENTRY	38	102
WINTER MOON	42	
WOLVERINE	2	
WORLD WING #2	54	31
YAMATAKA MARU	74	
YANKEE CLIPPER	105	
YOKOHAMA	20	36
YOUNG SKIPPER	51	
YOUNG SPROUT	64	37
ZEELANDIA	71	
ZIM AMERICA	9	
ZIM CALIFORNIA	20	
ZIM CANADA	23	
ZIM GENOVA	44	
ZIM HAIFA	38	
ZIM HONGKONG	76	
ZIM HOUSTON	53	
ZIM IBERIA	37	
ZIM KEELUNG	53	
ZIM KINGSTON III	296	
ZIM MARSEILLES	28	
ZIM MIAMI	37	
ZIM NEW YORK	96	
ZIM SAVANNAH	44	
ZIM TOKYO	101	
ZOELLA LYKES	22	

SUMMARY: GRAND TOTAL VIA RADIO 58918

GRAND TOTAL VIA MAIL 53251

TOTAL UNIQUE OBS 87784

TOTAL DUPLICATES 24385 (27.8%)

UNIQUE RADIO OBS.34533 (39.3%)

UNIQUE MAIL OBS. 28866 (32.9%)

October, November and December 1990

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
A3BE	107	107	0	COLUMBUS CANADA
A3BZ	78	78	0	ACT 12
A8VI	62	62	0	PACDUCHESS
BNPC	5	5	0	***
C8VM	10	10	0	VINA DEL MAR
CGDV	208	208	0	W. TEMPLEMAN
C6HL	47	47	0	LAZY JEAN
DAKE	110	110	0	KOELN ATLANTIC
DA9100	161	161	0	NORDSEE
DBLK	103	103	0	POLAR STERN
DGLM	92	92	0	MONTE ROSA
DGVK	41	41	0	COLUMBUS VICTORIA
DGZV	28	28	0	COLUMBUS VIRGINIA
DHCW	43	43	0	COLUMBUS WELLINGTON
DHOU	38	38	0	PURITAN
DIDA	24	24	0	ARIANA
DLEZ	34	34	0	YANKEE CLIPPER
DPIB	5	5	0	ICEBIRD
D5NZ	70	70	0	POLYNESIA
ELBX5	28	28	0	PACKING
ELED7	23	23	0	PACPRINCE
ELED8	51	51	0	PACPRINCESS
ELEH	32	32	0	***
ELHL6	140	140	0	COLUMBUS OHIO
ELJP8	8	8	0	CALIFORNIA ZEUS
EREA	169	141	28	MUSSON
EREH	42	13	29	PRIBOY
EREI	45	3	42	OKEAN
ERES	77	64	13	VICTOR BUGAEN
ERET	22	22	0	GEORGE OUSHAKOV
FNCZ	55	55	0	LIBREVILLE
FNED	5	5	0	***
FNGB	64	64	0	MARION DUFRESNE
FNJT	34	34	0	KORRIGAN
FNOM	21	21	0	ANGO
FNPA	15	15	0	MONSARO
FNQB	21	21	0	ILE MAURICE
FNQM	18	18	0	VILLE DE MARSEILLE
FNZB	3	3	0	SAINT ROLAND
FNZO	34	34	0	RABELAIS
FNZP	23	23	0	RACINE
FNZQ	26	26	0	RIMBAUD
FOUR	5	5	0	OCEANOUNIT FOUR
FPYO	6	6	0	CAP SAINT PAUL
FWQP	14	14	0	A. NIZERY
GOVL	19	19	0	ACT4
GOVN	77	77	0	ACT 6
GPHH	41	41	0	FARNELLA
GQEK	12	12	0	FORTHBANK
GTIA	76	76	0	IVYBANK
GYRW	3	3	0	ENCOUNTER BAY
GYSA	18	18	0	FLINDERS BAY
GYSE	11	11	0	NEDLLOYD TASMAN
GZKA	69	69	0	ACT 3
HPAN	31	31	0	MICRONESIAN COMMERCE
HPEW	69	69	0	PACIFIC ISLANDER
H8CB	11	11	0	TILLY
H9BQ	3	3	0	MICRONESIAN INDEPENDENCE
JBOA	18	18	0	KEIFU MARU
JCCX	95	95	0	CHOFU MARU
JCDF	42	42	0	SOYO MARU
JDRD	20	20	0	SHOYO MARU
JDWX	94	94	0	KOFU MARU
JFDG	71	71	0	SHUMPU MARU
JGDW	50	50	0	KEITEN MARU
JGZK	109	109	0	RYOFU MARU
JHAB	1	1	0	BOUSEI MARU
JITV	297	297	0	CANBERRA MARU
JIVY	2	2	0	***
JNVF	65	65	0	KAIYO MARU
JPVB	61	61	0	SEIFU MARU
JSVY	10	10	0	SHIRASE
J8FO	84	84	0	ROSEBANK
KGJB	15	15	0	***
KGWU	22	22	0	TH. WASHINGTON
KIRH	19	19	0	SEA-LAND TRADER
KNBD	30	30	0	DELAWARE II
KNFG	39	39	0	SEA WOLF
KRGB	67	67	0	SEA-LAND ENTERPRISE
LADB2	21	21	0	SHAUGRAN
LADC2	6	6	0	SKAUBORD
LOAI	4	4	0	ALMIRANTE IRIZAR
NAEE	13	13	0	DE STEIGUER
NAWR	5	5	0	ARTHUR RADFORD
NGDF	17	17	0	MUNRO
NHDB	42	42	0	TRUETT
NICB	2	2	0	***
CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
NIKA	47	47	0	SEALIFT ATLANTIC
NMEL	14	14	0	MELLON
NPGC	1	1	0	CUSHING
NQST	10	10	0	SEALIFT ARCTIC
NRCD	1	1	0	***
NRUO	121	121	0	POLAR SEA
NSHE	1	1	0	SHERMAN
NYGG	61	61	0	CHAUVENET
OWEQ2	14	14	0	MCKINNEY MAERSK
OWUO6	119	119	0	MOANA PACIFIC COBENHAVN
OWVG2	1	1	0	POLAR NANOQ
OXMD2	3	3	0	LARS MAERSK
PGDG	14	14	0	NEDLLOYD KINGSTON
PGDI	54	54	0	NEDLLOYD MANILA
PGDT	32	32	0	NEDLLOYD BALTIMORE
PGDV	67	67	0	NEDLLOYD BANGKOK
PGEH	70	70	0	NEDLLOYD BAHRAIN
PGEM	52	52	0	NEDLLOYD BARCELONA
PJJU	155	155	0	OLEANDER
PJYG	19	19	0	HIBISCUS
PWAN	6	6	0	***
SCRIPP	1	1	0	SCRIPP INST.
SHIP	540	540	0	***
S6FK	45	45	0	SWAN REEFER
TWR3	3	3	0	***
UEAK	52	0	52	VALERIAN URYVAYEV
UFYN	73	0	73	KAPITAN SHAYTANOV
UHQS	71	4	67	AKADEMIK KOROLEV
UINF	129	122	7	GLADIMIR PARSHIN
UJJS	86	0	86	***
UMAY	21	0	21	AKADEMIK SHIRSHOV
UMFW	103	103	0	PROF. ZUBOV
UPUI	75	75	0	PROFESSOR VIZE
UQHM	103	7	96	ABAKANLES
UQYC	27	27	0	AKADEMIK FEDOROV
UUPB	11	0	11	AKADEMIK M. SHOKALSKIY
UUQR	2	2	0	MOLCHANOV PAVEL FBO
UVMM	122	114	8	GAKKEL, YAKOV
UWEC	79	0	79	PROFESSOR KHROMOV
UZCB	22	2	20	VADIM POPOV
UZGH	135	116	19	PASSAT
VCTF	41	41	0	CAPE BRIER
VJBQ	29	29	0	ANRO AUSTRALIA
VJDP	43	43	0	***
VKCK	59	59	0	STUART
VKLA	4	4	0	ADELAIDE
VKLC	1	1	0	BRISBANE
VKML	33	33	0	SYDNEY
VKMN	7	7	0	PARRAMATTA
VKPT	27	27	0	PERTH
VMAP	62	62	0	AUSTRALIAN PROGRESS
VXN8	13	13	0	AIRCRAFT
WCGN	2	2	0	CHEVRON CALIFORNIA
WLDZ	16	16	0	***
WPKD	177	177	0	SEA-LAND ACHIEVER
WRBA	1	1	0	PACMISRANFAC HAWAREA
WRBB	14	14	0	***
WSRL	47	47	0	SEA-LAND PACIFIC
WTDF	25	25	0	T. CROMWELL
WTDK	137	137	0	D.S. JORDAN
WTDM	37	37	0	M.FREEMAN
WTDO	52	52	0	OREGON II
WTEA	179	179	0	DISCOVERER
WTED	16	16	0	CHAPMAN
WTEF	1	1	0	RAINIER
WTEG	15	15	0	MOUNT MITCHELL
WTEJ	220	220	0	MCARTHUR
WTEK	1	1	0	DAVIDSON
WTER	50	50	0	M. BALDRIDGE
WTES	67	67	0	SURVEYOR
WTEW	29	29	0	WHITING
WTEZ	8	8	0	FERREL
WUS9293	30	30	0	MOANA WAVE
WXQ7334	3	3	0	PETER ANDERSON
WYR4401	13	13	0	W. J. DELANCY
ZBDE	4	4	0	***
ZCKP	8	8	0	STAR HONGKONG
ZCSK	47	47	0	SKEENA
ZCSL	20	20	0	NIMOS
ZCUZ	1	1	0	POYANG
ZMCR	12	12	0	CANTERBURY
3DTF	20	20	0	SOUTHLAND STAR
3EAJ	12	12	0	PACIFIC FERNANDA
3EBD	55	55	0	PACIFIC GRACIA
3EET4	15	15	0	SEAS EIFFEL
7JOB	31	31	0	SHIN KASHU MARU
7KDD	16	16	0	YOKO MARU
9VUU	16	16	0	ANRO ASIA
9VVB	81	81	0	GOLDENSARI INDAH
9VWM	16	16	0	***

TOTAL BATHYS	RECEIVED	7732
TOTAL TESACS	RECEIVED	651
TOTAL REPORTS	RECEIVED	8383

NDBC Station Data Summary

October, November and December 1990

Wave observations are taken each hour during a 20–minute averaging period, with a sample taken every 0.67 seconds. The significant wave height is defined as the average height of the highest one–third of the waves during the hourly averaging period. The maximum significant wave height is the highest of those values for that month. At most stations, air temperature, water temperature, wind speed and direction are sampled once per second during an 8.0–minute averaging period each hour (moored buoys) and a 2.0–minute averaging period for fixed stations (C–MAN). Contact NDBC Data Systems Division, Bldg 1100, SSC, Mississippi 39529 or phone (601) 688–2838 for more details.

OCTOBER 1990

MEAN BUOY	MEAN LAT (C)	MEAN LONG (M)	SIG OBS	MAX SIG AIR TP (M)	MAX SIG SEA TP (DA/HR)	SCALAR MEAN WAVE HT (KNOTS)	PREV WAVE HT (DIR)	MAX WAVE HT (KTS)	MAX WIND (DA/HR)	MEAN SPEED (MB)	WIND	WIND	WIND	PRESS
41001	34.9N	073.0W	0740	22.5	24.8	2.0	8.9	26/20		13.5	SE	46.2	26/18	1017.6
41002	32.3N	075.2W	0739	24.4	26.1					11.0	E	29.9	26/12	1017.3
41006	29.3N	077.4W	0742	25.7	27.2	2.0	5.4	09/23		12.6	E	26.8	10/20	1016.2
41008	30.7N	081.1W	0741	24.4	26.1	1.2	3.1	12/04		11.4	NE	26.2	12/01	1016.7
41009	28.5N	080.2W	1476	26.1		1.6	4.3	10/00		12.9	E	27.8	10/14	1015.3
41010	28.9N	078.5W	1475	25.8	27.3	1.9	4.8	09/22		13.9	E	33.2	09/23	1015.7
42001	25.9N	089.7W	0738	25.9	28.3	1.0	3.5	10/19		11.0	E	23.3	10/16	1015.7
42002	25.9N	093.6W	0740	25.5	27.7	1.0	4.1	10/13		10.8	NE	28.2	10/08	1015.9
42003	25.9N	085.9W	0740	26.3	28.0	1.1	3.5	26/06		11.5	NE	26.8	26/05	1015.8
42007	30.1N	088.8W	0742	22.0	25.2					10.9	N	27.4	10/12	1017.2
42019	27.9N	095.0W	0741	24.3	27.3	1.0	4.2	10/04		10.5	N	28.0	10/03	1017.0
42020	27.0N	096.5W	0381	26.3	28.4	1.0	3.7	09/23		11.0	SE	29.1	09/19	1015.2
44001	38.4N	073.7W	0740	18.2	19.8	1.7	6.0	27/01		12.4	S	36.3	26/13	1017.9
44004	38.5N	070.7W	0740	19.5	21.7	2.1	8.1	27/02		13.3	S	42.2	26/23	1017.7
44005	42.7N	068.6W	0741	12.9	12.7	1.7	5.1	27/01		14.2	SW	33.0	26/22	1016.0
44007	43.5N	070.1W	0742	11.6	12.1	1.0	2.8	15/04		13.4	SW	31.7	29/16	1016.1
44008	40.5N	069.4W	0742	16.2	16.5	1.9	6.9	27/02		15.1	S	45.7	27/00	1017.8
44009	38.5N	074.7W	0742	18.1	19.5	1.3	4.6	26/18		13.7	S	35.8	26/09	1017.9
44011	41.1N	066.6W	0731	15.4	15.4	2.2	7.5	30/03		13.2	S	40.6	14/14	1016.3
44012	38.8N	074.6W	0681	18.0	18.9	1.2	3.5	26/13		14.8	S	38.7	26/12	1017.6
44013	42.4N	070.8W	0742	13.3	13.1	0.7	3.8	27/05		14.0	S	39.8	19/18	1015.6
44014	36.6N	074.8W	0722	19.6	20.6	1.7	6.4	26/16		11.3	S	42.0	26/13	1018.4
44015	37.1N	073.6W	0741	20.0	22.3	1.8	8.0	26/16		12.1	S	44.5	26/16	1018.1
45001	48.0N	087.7W	0738	5.7	6.0	1.0	5.1	18/08		12.0	S	36.3	18/01	1013.7
45002	45.3N	086.4W	0738	9.4	11.4	1.2	3.7	04/01						1015.0
45003	45.3N	082.7W	0742	8.6	9.2	1.2	4.4	28/08		11.2	S	28.8	28/06	1015.4
45004	47.5N	086.5W	0738	6.1	7.0	1.0	4.6	18/18						1013.8
45005	41.7N	082.4W	0740	12.9	15.0	0.8	2.6	19/01		13.2	SW	32.4	19/02	1016.7
45006	47.3N	089.9W	0742	7.7	8.8	0.9	5.7	18/02		11.6	W	37.7	17/23	1013.7
45007	42.7N	087.1W	0736	10.9	11.7	1.1	3.9	18/22		13.5	S	35.9	18/17	1015.7
45008	44.3N	082.4W	0738	10.0	11.1	1.3	4.1	19/04		12.6	NW	26.2	28/11	1016.8
46001	56.3N	148.3W	0740	6.9	8.4	3.0	7.3	11/23		16.5	W	39.6	12/22	1001.4
46002	42.5N	130.4W	0741	15.8	17.4	2.9	5.9	18/14						1020.6
46003	51.9N	155.9W	0740	7.5	8.7	3.1	6.5	11/14		18.3	W	32.8	11/04	1008.8
46006	40.8N	137.7W	0738	16.3	17.9	2.4	6.0	26/22		13.6	SW	33.4	26/18	1021.7
46010	46.2N	124.2W	0739	12.2	12.7	2.6	5.6	30/19		11.8	S	40.4	29/23	1018.7
46011	34.9N	120.9W	0741	16.0	16.5	2.3	3.8	03/18		8.7	N	23.7	20/01	1015.9
46012	37.4N	122.7W	0740	13.2	13.2	2.0	4.0	03/08		10.0	NW	21.9	02/09	1016.9
46013	38.2N	123.3W	0740	12.6	12.2	2.1	4.4	03/02		13.4	NW	30.2	03/03	1016.8
46014	39.2N	124.0W	0738	12.4	12.0	2.4	5.1	03/00		12.3	NW	35.4	03/00	1017.5
46022	40.8N	124.5W	0742	11.7	11.0	2.8	6.5	13/22		9.0	N	30.4	31/00	1019.7
46023	34.3N	120.7W	0742	16.0	15.9	2.1	3.8	07/06		12.8	NW	25.6	20/00	1014.6
46025	33.8N	119.1W	0682	18.8	20.2	1.0	1.7	20/01		5.3	W	15.2	06/09	1014.8
46026	37.8N	122.7W	0375	13.1	13.7	1.7	3.2	03/04		9.4	NW	25.6	02/12	1016.7
46027	41.8N	124.4W	0737	10.7	9.9	2.3	4.8	31/02		10.6	N	29.5	07/02	1019.1
46028	35.8N	121.9W	0742	15.1	15.0	2.3	4.7	03/05		13.6	NW	28.0	16/04	1016.4
46030	40.4N	124.5W	0732	11.3	13.4	2.2	5.0	31/03		11.7	N	29.3	30/18	1018.7
46035	57.0N	177.7W	0740	4.5	6.3	2.8	5.9	19/14		17.3	W	32.6	11/04	1006.8
46040	44.8N	124.3W	0738	12.6	13.4	2.7	6.4	18/19		10.8	S	31.3	30/01	1019.7
46041	47.4N	124.5W	0742	11.6	12.8	2.7	6.5	18/16		11.8	SE	30.3	29/23	1017.8
46042	36.8N	122.4W	0742	14.0	14.8	2.3	4.1	03/06		12.0	NW	25.1	02/23	1016.8
51001	23.4N	162.3W	0738	26.0	26.8	2.0	3.5	12/04		13.9	E	29.4	21/02	1016.8
51002	17.2N	157.8W	0612	26.4	26.9	2.1	3.3	07/08		15.7	E	22.6	07/20	1014.1
51003	19.2N	160.8W	0738	26.7	27.5	2.0	2.9	12/07		14.1	NE	23.0	11/12	1014.3
51004	17.5N	152.6W	0741	26.1	26.5	2.2	3.4	30/10		14.3	E	22.9	30/06	1015.1
52009	13.2N	144.5E	0741	28.1	29.1	1.3	3.3	23/13						1009.9
ALSN6	40.5N	073.8W	0741	16.1	16.9	0.9	2.6	19/00		16.2	S	40.5	19/00	1017.6
BURL1	28.9N	089.4W	0742	22.4						11.7	N	30.0	10/09	1016.4
BUZM3	41.4N	071.0W	0513	14.6		1.1	3.0	19/09		17.5	NW	40.9	26/14	1015.1
CARO3	43.3N	124.4W	0742	11.7						8.5	S	32.0	30/11	1020.3
CHLV2	36.9N	075.7W	0737	19.5	21.3	1.1	4.0	26/05		14.2	S	46.8	26/11	1019.4
CLKN7	34.6N	076.5W	0742	21.5						10.6	SE	36.7	26/10	1018.8
CSBF1	29.7N	085.4W	0740	22.3						6.0	N	20.4	25/17	1016.9
DBLN6	42.5N	079.4W	0708	11.9						13.0	SW	43.3	18/20	1016.6
DESW1	47.7N	124.5W	0742	10.9						12.9	E	39.5	25/17	1017.7
DISW3	47.1N	090.7W	0740	8.0						11.9	SW	44.9	17/21	1014.7
DPIA1	30.3N	088.1W	0708	21.4	23.2					10.3	N	27.7	19/06	1017.2
DSLN7	35.2N	075.3W	0741	22.2	25.7	1.6	7.7	26/15		15.2	SE	53.5	26/11	1018.5
ENIP2	11.4N	162.4E	0737	28.0						9.4	E	27.8	13/13	1009.5
FARP2	8.6N	144.6E	0737	28.2						7.1	SW	29.3	02/11	1009.2
FBIS1	32.7N	079.9W	0741	22.0						10.0	E	26.5	10/20	1017.9
FPSN7	33.5N	077.6W	0742	23.2						14.4	E	43.7	26/10	1018.2
GBCL1	27.8N	093.1W	0742	23.6	27.5	0.7	3.6	10/06		11.7	N	31.3	18/13	1017.5
GDIL1	29.3N	090.0W	0742	21.8						9.5	N	29.9	10/09	1017.3

MEAN BUOY (C)	MEAN LAT (C)	MEAN LONG (M)	SIG OBS	MAX SIG AIR TP (M)	MAX SIG SEA TP (DA/HR)	SCALAR MEAN WAVE HT (KNOTS)	PREV WAVE HT (DIR)	MAX WAVE HT (KTS)	MAX WIND (DA/HR)	MEAN SPEED (MB)	WIND	WIND	WIND	PRESS
GLLN6	43.9N	076.5W	0739	11.1						14.4	NE	38.0	19/01	1015.9
IOSN3	43.0N	070.6W	0741	12.5						15.3	W	36.4	19/04	1016.8
KOSP2	5.4N	163.0E	0741	26.9						4.5	E	22.7	10/12	1009.0
LKWF1	26.6N	080.0W	0719	26.4	27.7					12.9	E	33.2	10/10	1014.7
MDRM1	44.0N	068.1W	0741	11.0						17.8	SW	42.0	19/23	1015.3
MISM1	43.8N	068.9W	0741	11.3						17.7	SW	39.0	19/13	1014.9
MLRF1	25.0N	080.4W	0652	27.4	28.6					12.9	E	28.7	09/13	1014.7
MPCL1	29.4N	088.6W	0739	23.0	26.3	0.8	2.4	10/15		10.8	NE	26.4	25/07	1016.7
NWPO3	44.6N	124.1W	0742	10.9						7.6	E	29.0	27/22	1018.9
PAGP2	18.1N	145.8E	0721	27.5						8.6	E	34.8	17/22	1010.3
PILM4	48.2N	088.4W	0742	6.4						13.9	W	40.9	04/22	1014.4
PTAC1	39.0N	123.7W	0743	11.7						9.3	N	26.2	04/20	1017.9
PTAT2	27.8N	097.1W	0741	23.3	25.3					12.0	NE	32.7	09/20	1017.1
PTGC1	34.6N	120.7W	0743	15.6						12.3	N	26.8	16/02	1015.4
ROAM4	47.9N	089.3W	0740	6.8	8.3					14.4	N	44.5	17/22	1015.3
SAUF1	29.9N	081.3W	0739	24.0	26.0					11.6	SE	30.6	12/03	1016.2
SBIO1	41.6N	082.8W	0707	12.4						13.3	SW	41.3	19/01	1014.3
SGNW3	43.8N	087.7W	0716	9.8						14.2	S	32.5	10/15	1015.4
SISW1	48.3N	122.9W	0742	10.3						11.1	SE	38.0	27/23	1017.6
SMKF1	24.6N	081.2W	0738	26.7	28.1					13.9	E	31.6	10/13	1013.9
SPGF1	26.7N	079.0W	0742	26.6	28.3					9.9	E	26.2	09/17	1014.3
SRST2	29.7N	094.1W	0743	20.8						9.2	SE	22.2	10/07	1018.9
STDM4	47.2N	087.2W	0742	6.6						17.3	S	48.0	18/15	1014.7
SVLS1	32.0N	080.7W	0741	22.8		1.0	2.4	12/05		13.8	NE	37.3	26/02	1018.2
TPLM2	38.9N	076.4W	0739	17.2	19.0					12.0	S	31.9	19/03	1018.2
TTIW1	48.4N	124.7W	0626	9.9						12.7	S	43.0	25/17	1017.7
UJAP2	8.9N	165.8E	0735	28.0						5.6	E	18.7	19/13	1009.1
VENF1	27.1N	082.5W	0742	24.3	26.9					8.2	NE	39.8	11/08	1015.2
WPOW1	47.7N	122.4W	0689	10.8						8.3	S	28.2	04/03	1017.2
NOVEMBER		**1990**												
41001	34.9N	073.0W	0719	18.9	22.4	2.1	6.0	11/00		14.6	NW	33.8	10/13	1018.8
41002	32.3N	075.2W	0720	20.9	23.4					11.8	NE	29.1	10/10	1019.6
41006	29.3N	077.4W	0720	22.9	25.2	1.7	4.8	30/16		12.1	NE	26.4	30/20	1019.4
41008	30.7N	081.1W	0720	19.8	21.1	1.0	2.5	30/08		9.9	NE	25.3	30/03	1020.4
41009	28.5N	080.2W	1349	23.2	25.3	1.3	3.1	05/09		11.7	NE	26.2	30/01	1018.8
41010	28.9N	078.5W	1437	23.1	25.1	1.6	4.1	30/14		13.0	NE	30.7	30/08	1019.2
42001	25.9N	089.7W	0720	23.4	25.5	1.4	4.2	29/22		13.3	E	30.9	29/20	1018.6
42002	25.9N	093.6W	0718	23.6	25.2	1.5	5.6	29/21		12.6	SE	32.1	29/17	1017.8
42003	25.9N	085.9W	0720	23.8	25.2	1.3	4.1	30/10		12.7	E	28.8	29/23	1019.2
42007	30.1N	088.8W	0718	18.4	20.5					11.5	E	31.3	10/01	1020.3
42019	27.9N	095.0W	0720	22.0	24.3	1.4	4.8	29/20		12.7	SE	29.3	29/14	1018.7
42020	27.0N	096.5W	0585	22.5	24.3	1.5	4.9	29/19		12.8	SE	29.5	09/09	1019.0
44001	38.4N	073.7W	0716	12.7	14.9	1.4	7.7	10/17		15.2	SW	32.4	12/08	1018.0
44004	38.5N	070.7W	0720	14.0	16.8	2.4	7.5	12/10		16.2	NW	42.2	12/08	1016.7
44005	42.7N	068.6W	0720	7.6	9.5	2.1	6.4	19/15		17.7	W	35.6	19/06	1012.7
44007	43.5N	070.1W	0718	6.3	9.0	0.8	5.1	11/04		15.6	SW	41.0	06/13	1013.4
44008	40.5N	069.4W	0716	10.0	11.4	2.0	7.0	12/11		18.3	NW	44.1	12/08	1015.3
44009	38.5N	074.7W	0720	11.7	13.8	1.1	4.1	10/18		13.7	SW	35.9	12/08	1018.2
44011	41.1N	066.6W	0702	9.8	10.5	2.5	7.3	11/16		16.2	NW	40.2	12/13	1013.1
44012	38.8N	074.6W	0240	10.2	14.6	1.3	4.6	10/19		21.0	W	44.9	12/06	1017.0
44013	42.4N	070.8W	0719	7.9	9.7	0.7	4.0	19/07		16.3	SW	35.8	12/12	1013.1
44014	36.6N	074.8W	0719	14.0	15.5	1.5	5.9	10/13		13.0	SW	33.4	10/12	1019.4
44015	37.1N	073.6W	0719	14.7	17.3	1.7	6.5	10/16		14.1	NW	37.7	10/13	1018.7
45001	48.0N	087.7W	0715	1.7	4.5	1.4	4.3	22/14		15.3	NW	30.3	22/10	1012.3
45002	45.3N	086.4W	0718	5.1	8.3	1.3	4.5	30/21						1014.9
45003	45.3N	082.7W	0375	4.9	7.1	1.5	4.6	11/21		13.4	NW	30.1	11/21	1016.4
45004	47.5N	086.5W	0719	2.4	4.8	1.4	4.2	25/12						1012.4
45005	41.7N	082.4W	0719	7.5	9.0	0.7	2.5	06/03		12.9	SW	32.8	06/04	1017.9
45006	47.3N	089.9W	0685	2.9	5.8	1.0	3.4	22/10		14.4	NW	32.6	22/02	1012.8
45007	42.7N	087.1W	0119	9.4	9.3	1.0	2.9	05/21		13.4	S	27.4	05/22	1014.4
45008	44.3N	082.4W	0323	5.2	7.7	1.5	4.5	12/01		13.7	NW	33.4	06/06	1017.8
46001	56.3N	148.3W	0719	2.7	5.7	3.9	10.3	26/10		21.1	NW	41.2	26/07	1006.8
46002	42.5N	130.4W	0719	13.8	15.6	3.1	6.2	20/11						1022.4
46003	51.9N	155.9W	0719	4.6	6.1	3.5	8.2	15/18		18.4	NW	35.9	15/13	1017.4
46006	40.8N	137.7W	0719	14.5	15.7	2.8	5.7	13/04		16.4	SW	32.1	12/04	1023.8
46010	46.2N	124.2W	0642	10.9	11.9	2.7	5.7	24/04		16.3	S	37.9	24/00	1018.7
46011	34.9N	120.9W	0719	14.5	14.8	2.0	4.7	27/01		9.1	NW	28.7	26/09	1018.8
46012	37.4N	122.7W	0720	12.1	11.9	1.9	4.4	26/20		11.5	NW	30.1	06/03	1020.1
46013	38.2N	123.3W	0718	11.9	11.6	2.0	4.0	26/20		12.6	NW	31.2	06/02	1020.6
46014	39.2N	124.0W	0719	11.5	12.0	2.5	4.9	20/20		10.6	NW	28.4	14/03	1021.4
46022	40.8N	124.5W	0719	11.0	11.6	2.7	6.0	20/15		8.5	N	27.1	26/03	1023.2
46023	34.3N	120.7W	0717	14.9	15.3	2.0	4.7	20/16		13.0	NW	30.9	26/11	1017.5
46025	33.8N	119.1W	0719	17.3	18.3	1.0	3.1	26/12		8.3	NW	30.4	26/11	1017.3
46026	37.8N	122.7W	0719	11.9	11.4	1.4	3.2	26/23		10.7	NW	32.6	06/03	1020.3
46027	41.8N	124.4W	0717	10.0	10.7	2.3	5.2	20/13		8.7	N	24.7	25/10	1022.6
46028	35.8N	121.9W	0719	14.3		2.3	4.6	26/14		12.1	NW	29.3	06/05	1019.5
46030	40.4N	124.5W	0712	10.5		2.2	5.0	20/20		11.0	N	25.6	06/04	1022.2
46035	57.0N	177.7W	0718	2.8	4.4	3.4	8.8	16/21		19.8	SW	47.6	18/22	1018.0
46040	44.8N	124.3W	0582	11.3	12.3	2.7	5.9	20/13		13.3	S	29.1	24/15	1021.0
46041	47.4N	124.5W	0718	9.9	11.5	2.9	6.2	24/00		14.2	NW	30.9	23/21	1017.6
46042	36.8N	122.4W	0717	12.4	12.7	2.1	4.5	27/00		11.5	NW	26.2	06/15	1020.1
51001	23.4N	162.3W	0717	24.6	26.1	3.3	7.8	18/18		14.3	E	34.7	18/18	1013.7
51002	17.2N	157.8W	0719	26.0	26.7	2.5	4.9	25/16		13.7	E	25.3	19/18	1012.3
51003	19.2N	160.8W	0719	25.7	26.9	2.5	4.9	25/11		12.9	E	27.5	13/05	1012.1
51004	17.5N	152.6W	0719	25.8	26.6	2.8	5.7	26/04		15.6	E	27.1	19/17	1014.0
52009	13.2N	144.5E	0681	27.8	28.6	1.8	4.5	29/12		14.1	E	31.9	22/18	1008.5
ALSN6	40.5N	073.8W	0712	10.2	12.8	0.7	3.2	10/16		18.6	NW	48.0	10/16	1017.1
BURL1	28.9N	089.4W	0717	19.4						12.7	NE	36.9	09/17	1019.2
BUZM3	41.4N	071.0W	0719	9.4		1.1	4.1	11/04		19.2	SW	47.8	12/04	1015.9
CARO3	43.3N	124.4W	0720	10.5						9.9	S	33.4	25/08	1022.5
CHLV2	36.9N	075.7W	0705	13.2	14.8	0.9	2.9	10/14		15.3	SW	36.3	11/03	1020.2
CLKN7	34.6N	076.5W	0719	15.7						9.8	N	32.8	10/08	1020.9
CSBF1	29.7N	085.4W	0715	18.1						5.8	E	27.9	10/03	1020.7
DBLN6	42.5N	079.4W	0713	7.7						15.6	SW	53.1	06/08	1017.0
DESW1	47.7N	124.5W	0719	9.2						16.7	E	42.6	23/22	1017.3
DISW3	47.1N	090.7W	0711	2.8						14.2	W	37.3	22/08	1014.1
DPIA1	30.3N	088.1W	0702	17.5	18.7					10.0	NE	30.0	30/00	1021.3
DSLN7	35.2N	075.3W	0720	17.4	23.6	1.5	5.4	10/12		17.3	N	50.3	10/11	1020.2

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
ENIP2	11.4N	162.4E	0720	27.6					14.2	E	36.5	22/14	1006.6
FARP2	8.6N	144.6E	0665	28.0					8.1	NE	34.3	08/01	1006.5
FBIS1	32.7N	079.9W	0720	16.7					8.0	NE	29.9	10/02	1021.0
FFIA2	57.3N	133.6W	0718	1.2					20.3	N	46.4	12/22	1005.7
FPSN7	33.5N	077.6W	0719	19.2					14.3	N	49.1	10/07	1020.7
GBCL1	27.8N	093.1W	0719	21.5	25.1	0.8	3.0	29/16	14.5	SE	36.3	29/13	1019.5
GDIL1	29.3N	090.0W	0717	19.0					10.0	NE	30.3	10/04	1020.1
GLLN6	43.9N	076.5W	0716	5.5					16.3	S	45.4	06/14	1016.0
IOSN3	43.0N	070.6W	0720	7.3					17.8	W	46.9	11/00	1014.2
KOSP2	5.4N	163.0E	0718	27.8					7.8	SW	27.9	12/06	1006.2
LKWF1	26.6N	080.0W	0716	23.5	25.7				12.7	E	29.8	30/19	1018.4
MDRM1	44.0N	068.1W	0718	5.8					21.3	NW	52.0	11/03	1011.4
MISM1	43.8N	068.9W	0700	6.1					20.8	NW	55.0	11/03	1011.5
MLRF1	25.0N	080.4W	0717	24.4	26.3				15.0	E	29.2	30/14	1017.4
MPCL1	29.4N	088.6W	0713	20.3	23.1	0.8	2.4	30/04	13.1	E	36.9	10/01	1019.7
NWPO3	44.6N	124.1W	0719	9.8					10.5	E	35.0	29/14	1020.4
PAGP2	18.1N	145.8E	0395	27.0					10.2	NE	16.7	30/03	1011.4
PILM4	48.2N	088.4W	0715	1.6					17.7	NW	39.8	22/08	1012.6
PTAC1	39.0N	123.7W	0720	10.2					8.5	N	26.1	26/03	1021.6
PTAT2	27.8N	097.1W	0719	20.3	21.6				11.4	SE	29.6	29/11	1018.5
PTGC1	34.6N	120.7W	0718	14.8					12.0	N	43.5	26/09	1018.2
ROAM4	47.9N	089.3W	0638	2.2	5.6				16.5	NW	35.8	22/02	1015.2
SAUF1	29.9N	081.3W	0717	19.4	21.2				9.4	NE	30.9	30/08	1020.0
SBIO1	41.6N	082.8W	0456	8.2					15.9	SW	44.0	06/01	1016.1
DECEMBER		**1990**											
41001	34.9N	073.0W	0743	17.9	21.0	2.3	6.1	04/23	16.6	S	31.1	08/11	1021.9
41002	32.3N	075.2W	0742	20.7	23.1	1.9	4.5	09/10	13.5	S	27.6	09/08	1022.0
41006	29.3N	077.4W	0744	22.0	24.3	1.8	4.2	09/08	11.8	SE	26.8	09/05	1022.2
41008	30.7N	081.1W	0744	16.5	17.7	1.1	2.2	03/21	9.4	N	23.9	05/06	1022.3
41009	28.5N	080.2W	1313	22.0	23.5	1.2	3.2	01/01	10.4	E	23.9	03/02	1021.4
41010	28.9N	078.5W	1487	22.0	24.4	1.7	4.3	01/00	12.8	SE	29.9	09/03	1021.8
42001	25.9N	089.7W	0744	21.8	24.2	1.4	4.3	08/08	13.8	SE	30.5	08/01	1019.6
42002	25.9N	093.6W	0742	21.9	23.9	1.6	4.3	24/04	13.0	SE	30.5	07/19	1018.2
42003	25.9N	085.9W	0744	22.5	24.0	1.2	3.6	08/12	13.5	SE	29.9	08/07	1020.8
42007	30.1N	088.8W	0744	13.8	17.0				11.6	SE	26.6	24/08	1021.2
42019	27.9N	095.0W	0743	19.0	22.5	1.5	3.9	24/04	12.6	SE	28.4	03/14	1019.1
42020	27.0N	096.5W	0744	19.1	22.7	1.5	4.0	07/13	13.6	SE	31.7	18/12	1018.9
44001	38.4N	073.7W	0743	10.2	12.4	1.7	4.2	28/11	15.2	SW	29.3	05/18	1021.4
44004	38.5N	070.7W	0743	11.4	12.6	2.5	6.0	05/00	15.2	NW	30.3	05/16	1021.3
44005	42.7N	068.6W	0743	5.2	7.6	2.2	4.7	04/14	17.2	SW	31.7	24/17	1018.5
44007	43.5N	070.1W	0743	2.7	6.6	1.1	5.2	04/14	14.4	SW	33.6	04/18	1018.7
44008	40.5N	069.4W	0742	7.7	8.9	2.1	5.2	05/09	18.2	W	34.2	06/01	1020.6
44009	38.5N	074.7W	0742	8.8	10.6	1.3	3.6	28/07	14.3	SW	31.1	28/02	1021.4
44011	41.1N	066.6W	0723	7.3	7.9	2.4	6.9	05/10	16.0	S	31.5	11/04	1019.3
44012	38.0N	074.6W	0050	10.0	9.3	1.5	2.0	31/09	21.3	S	26.8	31/10	1018.3
44013	42.4N	070.8W	0742	4.5	7.2	0.7	3.6	04/14	15.9	SW	41.4	31/09	1019.6
44014	36.6N	074.8W	0744	11.9	13.2	1.7	4.1	04/15	13.7	SW	26.8	14/11	1022.2
44015	37.1N	073.6W	0742	12.6	14.6	1.6	4.2	04/16					1021.9
45001	48.0N	087.7W	0042	-1.6	4.1	1.6	2.2	01/20	17.8	NW	24.3	01/20	1018.0
45002	45.3N	086.4W	0744	-1.3	6.0	1.3	4.6	03/22					1017.5
45004	47.5N	086.5W	0744	-2.2	4.0	1.6	3.9	23/02					1015.5
45005	41.7N	082.4W	0224	3.4	5.3	1.0	3.0	03/11	16.8	W	31.3	04/12	1018.4
46001	56.3N	148.3W	0743	3.2	4.4	3.5	9.2	14/03	17.4	SW	36.1	13/16	1010.5
46002	42.5N	130.4W	0741	10.3	13.2	3.5	11.1	19/16	16.7	N	35.4	14/18	1025.1
46003	51.9N	155.9W	0744	4.9	4.6	3.9	7.9	05/19	18.5	SW	36.3	17/20	1011.2
46006	40.8N	137.7W	0715	11.5	13.8	2.8	6.1	14/16	15.3	NW	36.1	03/16	1027.5
46010	46.2N	124.2W	0579	3.9	8.2	2.5	6.0	19/01	15.4	E	36.3	18/23	1020.5
46011	34.9N	120.9W	0742	12.0	14.2	2.0	5.2	20/09	10.0	NW	26.8	19/23	1019.8
46012	37.4N	122.7W	0744	9.7	11.7	2.0	4.6	19/21	12.0	NW	30.5	19/20	1020.8
46013	38.2N	123.3W	0741	9.0	10.6	2.3	6.2	19/23	12.3	NW	31.2	28/16	1021.3
46014	39.2N	124.0W	0744	8.8	10.9	2.7	7.2	20/00	11.7	N	30.5	19/17	1021.6
46022	40.8N	124.5W	0193	10.4	11.0	3.4	6.0	06/06	8.4	S	25.3	04/13	1026.9
46023	34.3N	120.7W	0741	12.6	14.3	2.2	6.0	20/12	13.4	NW	33.1	20/13	1018.3
46025	33.8N	119.1W	0744	14.3	16.1	1.0	3.1	20/01	7.6	NW	28.0	20/01	1018.3
46026	37.8N	122.7W	0739	8.8	10.3	1.5	3.7	20/00	11.8	NW	33.0	19/15	1021.0
46027	41.8N	124.4W	0734	7.2	9.7	2.5	7.0	19/16	11.9	N	31.1	19/08	1022.6
46028	35.8N	121.9W	0743	11.7		2.4	6.1	20/08	11.4	NW	28.3	20/00	1020.3
46030	40.4N	124.5W	0657	8.2		2.6	6.4	19/16	13.1	N	32.6	15/00	1022.0
46035	57.0N	177.7W	0741	1.3	3.0	3.6	10.4	02/13	18.1	E	41.8	02/07	1000.8
46041	47.4N	124.5W	0041	6.3	10.1	4.6	7.6	02/00	16.7	NW	30.7	01/18	1022.0
46042	36.8N	122.4W	0743	10.2	12.5	2.3	5.7	20/02	11.9	N	29.0	19/18	1020.8
51001	23.4N	162.3W	0744	23.2	24.7	3.0	5.2	14/22	15.2	E	27.6	25/07	1015.4
51002	17.2N	157.8W	0432	25.5	26.0	2.9	5.2	15/04	17.9	E	28.2	14/21	1014.9
51003	19.2N	160.8W	0742	24.7	25.8	2.6	4.0	15/14	11.2	E	18.6	10/00	1013.5
51004	17.5N	152.6W	0707	24.7	25.5	2.8	5.2	14/19	15.5	E	26.6	14/18	1014.9
52009	13.2N	144.5E	0465	27.4	28.0	1.8	9.8	20/14	14.5	E	49.4	20/14	1010.1
ALSN6	40.5N	073.8W	0718	6.1	9.3	1.0	3.4	04/02	17.9	W	42.6	04/10	1020.9
BURL1	28.9N	089.4W	0743	16.8					14.6	SE	30.3	07/22	1020.1
BUZM3	41.4N	071.0W	0741	6.1		1.3	3.3	24/16	19.1	SW	44.2	24/15	1020.9
CARO3	43.3N	124.4W	0743	5.2					9.6	SE	35.0	04/15	1023.3
CHLV2	36.9N	075.7W	0459	10.5	10.9	1.2	3.0	28/10	16.7	S	35.5	19/00	1023.0
CLKN7	34.6N	076.5W	0744	13.6					11.5	NE	25.8	04/05	1023.0
CSBF1	29.7N	085.4W	0742	15.6					6.0	E	19.2	24/05	1022.1
DBLN6	42.5N	079.4W	0738	2.6					15.2	SW	42.8	04/20	1018.5
DESW1	47.7N	124.5W	0742	4.1					16.6	E	46.3	04/05	1020.3
DISW3	47.1N	090.7W	0739	-5.5					15.3	SW	33.5	13/01	1018.3
DPIA1	30.3N	088.1W	0743	14.5	14.7				11.1	SE	27.6	24/07	1022.3
DSLN7	35.2N	075.3W	0742	16.1	21.1	1.7	3.8	04/09	19.5	N	43.0	04/15	1022.6
ENIP2	11.4N	162.4E	0743	27.4					16.4	E	34.5	16/00	1008.4
FBIS1	32.7N	079.9W	0742	13.0					8.8	NE	25.5	04/03	1023.0
FFIA2	57.3N	133.6W	0739	-0.2					16.9	N	52.0	27/10	1013.6
FPSN7	33.5N	077.6W	0743	17.7					17.6	N	39.6	04/09	1022.8
GBCL1	27.8N	093.1W	0668	19.9	23.4	0.9	2.5	24/03	15.9	S	36.4	03/16	1019.2
GDIL1	29.3N	090.0W	0605	14.9	15.7				10.3	SE	26.8	04/06	1022.5
GLLN6	43.9N	076.5W	0740	1.1					16.8	W	46.1	04/03	1018.5
IOSN3	43.0N	070.6W	0714	3.5					16.6	W	43.0	10/23	1019.4
KOSP2	5.4N	163.0E	0741	27.5					7.5	E	29.9	15/15	1007.2
LKWF1	26.6N	080.0W	0742	22.2					12.2	E	29.4	01/00	1020.8
MDRM1	44.0N	068.1W	0740	3.1					20.2	NW	45.0	04/13	1017.4

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
MISM1	43.8N	068.9W	0475	3.4					20.5	SW	49.0	04/13	1019.2
MLIP2	6.1N	172.6E	0485	27.4					9.4	NE	33.0	14/14	1006.4
MLRF1	25.0N	080.4W	0741	23.5	25.0				14.5	E	31.3	01/00	1019.8
MPCL1	29.4N	088.6W	0737	17.8	20.7	0.9	1.9	01/16	13.6	SE	30.1	24/04	1020.8
NWPO3	44.6N	124.1W	0743	4.2					10.2	E	39.0	04/14	1022.0
PAGP2	18.1N	145.8E	0744	26.4					8.2	NE	19.9	20/02	
PILM4	48.2N	088.4W	0730	-6.9					16.7	NW	35.8	01/01	1017.5
PTAC1	39.0N	123.7W	0743	7.0					9.1	N	31.7	20/00	1021.9
PTAT2	27.8N	097.1W	0719	15.2	16.8				11.0	SE	33.2	30/21	1019.3
PTGC1	34.6N	120.7W	0740	12.0					11.9	N	34.8	20/13	1019.1
ROAM4	47.9N	089.3W	0634	-7.2	3.4				16.0	W	35.6	28/07	1019.3
SAUF1	29.9N	081.3W	0737	16.5	18.2				8.8	N	25.0	27/01	1022.0
SBIO1	41.6N	082.8W	0714	1.9					15.4	SW	42.1	04/09	1019.1
SGNW3	43.8N	087.7W	0699	-3.1					13.5	W	45.2	03/18	1018.2
SISW1	48.3N	122.9W	0743	2.6					14.0	SE	46.0	04/04	1021.0
SMKF1	24.6N	081.2W	0736	23.3	24.5				15.5	E	32.7	01/01	1019.9
SPGF1	26.7N	079.0W	0741	22.2	25.0				9.9	E	25.3	01/02	1020.7
SRST2	29.7N	094.1W	0743	12.5					9.7	SE	22.4	27/02	1021.3
STDM4	47.2N	087.2W	0738	-4.0					20.8	W	45.0	04/04	1017.0
SVLS1	32.0N	080.7W	0741	14.3		0.9	2.1	27/18	13.3	NE	36.0	04/03	1023.5
TPLM2	38.9N	076.4W	0659	6.8	7.1				12.3	S	32.6	04/07	1022.1
TTIW1	48.4N	124.7W	0743	3.8					16.2	E	49.0	04/06	1020.2
UJAP2	8.9N	165.8E	0741	27.7					13.9	E	37.9	15/10	1007.8
VENF1	27.1N	082.5W	0743	18.2	19.4				7.7	E	26.1	08/13	1021.2
WPOW1	47.7N	122.4W	0742	3.1					11.5	S	37.9	27/07	1020.3

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